Volume 8
Number 88 *The vitality, adulteration and impurities of Clover, Alfalfa and Timothy seed for sale in Iowa in 1906.*

Article 1

August 2017

The vitality, adulteration and impurities of Clover, Alfalfa and Timothy seed for sale in Iowa in 1906.

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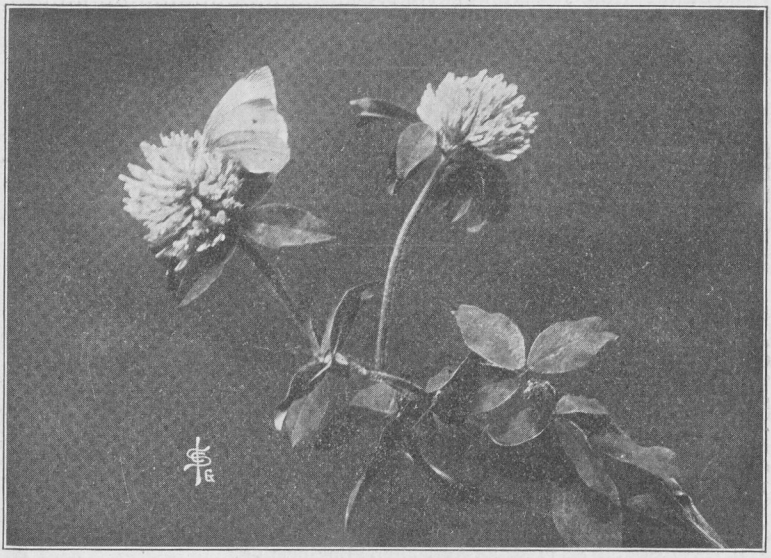
BULLETIN 88 JANUARY, 1907

EXPERIMENT STATION

IOWA STATE COLLEGE OF AGRICULTURE AND THE MECHANIC ARTS



BOTANICAL SECTION

The Vitality, Adulteration and Impurities of Clover, Alfalfa and Timothy Seed for Sale in Iowa in 1906

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THE VITALITY, ADULTERATION AND IMPURITIES OF CLOVER, ALFALFA AND TIMOTHY SEED FOR SALE IN IOWA IN 1906.

L. H. PAMMEL, R. E. BUCHANAN AND CHARLOTTE M. KING.

Clover and timothy are the most important hay crops grown in Iowa. The census of 1905 gives the area devoted to the growing of red clover in the state as 237,309 acres; of timothy as 3,642,424 acres. These figures do not include the area devoted to minor clover crops such as alsike and white clover. It may be said, however, that only a small area in the state is devoted to the growing of the former. The white clover crop covers a much larger area than any other of the leguminous plants. It is, however, seldom sown as a forage crop, but it is largely spontaneous in pastures. Some seasons it is abundant and in others it constitutes only a small part of the forage in pastures. In addition to its use for this purpose it is sown in lawns as a nurse crop. Alfalfa is cultivated only to a limited extent in Iowa; the area thus devoted is not ascertainable, but is small. The demand for alfalfa seed is continually increasing, largely because of the success attending its cultivation in suitable soils and locations. This success has induced a large number of farmers to try it in an experimental way.

The importance of these crops in this state, and the real danger of introducing serious weed pests emphasizes the need of care in selection of seeds. The seed for these crops is frequently grown in other states and often is poorly cleaned; thus the introduction of alfalfa has brought in a number of weeds new to the state. Some of them are quite dangerous. Among these may be mentioned the knapweed, a troublesome European spiny plant, closely related to the common bachelor's button, and alfilaria or burr clover. We may also recall here the introduction into this state of clover dodder, Canada thistle, ribgrass, and evening catchfly with imported clover seed. It was with these facts in mind that a study of the above seeds was undertaken in the spring of 1906. Such investigations not only enlighten the general public, but it is believed will materially raise the standard of seeds offered for sale in this state. Moreover, the improvement in the quality of seeds sown will mean a distinct saving to the purchaser amounting to a great many hundreds of dollars to say nothing of the saving of money and labor that will be required to exterminate these noxious weeds now introduced with

seed. The results reached will be of value to the farmer in showing the real need of investigation looking towards a careful seed inspection. We acknowledge with thanks the help received from Misses Estelle D. Fogel, Harriette S. Kellogg, Grace Ellis and Messrs. Snyder, Balthis and Bader.

EARLIER WORK AT IOWA STATION.

In 1891 one of us called attention to the occurrence[1] in clover meadows of ox-eye daisy, hawkweed and ribgrass which had been introduced with clover seed. In the same bulletin Prof. P. H. Rolfs reported on the occurrence of some common weed seeds found in clover offered for sale in Iowa that year. The weed seeds most abundant as reported by Prof. Rolfs were as follows: Buttercups, dock, sheep sorrel, cranesbill, pepper grass, bachelor's button, medic, vetch, corn cockle, pigweed or green amaranth, tumble-weed, lamb's-quarter, ribgrass, pigeon-grass or foxtail and green foxtail. Some years later Mr. F. C. Stewart[2] made a study of the impurities of clover seed grown in this state. Mr. Stewart examined eighty-four samples from different parts of the state. In these examinations thirty-five different kinds of weed seeds were found. The percentage of impurities varied from .3 to 67 per cent. The principal impurities occurred as follows: Dirt, sticks, etc. fifty-seven times, timothy fifty-two, green foxtail fifty, plantain forty-one, smartweed thirty-two, pigeon-grass thirty-one, smooth crabgrass twenty-four, lamb's-quarter twenty-six, barnyard-grass sixteen, old witch grass fifteen, small ragweed fourteen, pigweed twelve, dock eleven, sprouting crabgrass ten, sheep sorrel eight and ribgrass seven. The other weeds occurred from one to seven times. It is noteworthy, however, that Canada thistle and dodder were not found in a single case. Ribgrass was found seven times and bracted plantain twice. The weeds most commonly found in our Iowa grown seed are such as are common everywhere in the state.

A few years later Mr. C. R. Ball[3] called attention to the common impurities found in grass seeds. He also discussed the subject of seed testing, history, impurities, vitality; and gave the results of his study of the germination of a few of the more important seeds offered for sale in the state. Among these were a few clover and alfalfa seeds. In his study seeds were tested in the spring and samples of the same tested in the fall. Mr.

1 Pammel, Bull. Ia. Agr. Exp. Sta. 13:72.
2 The impurities of Clover Seed. Bull. Ia. Agr. Exp. Sta. 21:805. See also Proc. Ia. Acad. of Sci. 1-3:84.
3 Bull. Ia. Agr. Exp. Sta. 54:164-180.

Ball's results indicate that the seeds of these leguminous plants sown in the spring show a much higher percentage of germination than samples from the same lot of seeds sown in the fall. This paper also contains a bibliography of the more important papers published on the subject of purity, vitality and selection and the effect of chemicals on germination.

EUROPEAN WORK.

The importance of this work has long been recognized in Europe. The pioneer work in this line was carried on first in Germany, a station for testing commercial seeds having been organized in 1867 in connection with an academy located in Tharandt. Dr. Nobbe was its first director. Early in his work he saw the importance of making careful examinations for the impurities of various grass and clover seeds. In 1876 appeared his classical book. [1] In addition to this work he was the author of many other important papers on the subject of viability of seeds and other physiological seed problems. [2]

Among other important contributions along this line, we may mention the papers and work of Kraft, [3] Luhn [4] and Harz. [5] The work of Harz summarizes not only the facts pertaining to the anatomy of seeds but many other important physiological and chemical problems. The important literature bearing on the subject of seeds is also given.

The work of Burchard [6] on the adulteration of seeds with special reference to their origin is particularly noteworthy. In his book he has published statistical records showing the origin of clover seed and the weed seeds found in the same from Middle Europe, Eastern Europe, Southern Europe and North and South America. He sometimes missed the important weed species that are found in our American clover seed, but on the whole it is true that the character of the weed seeds found in our clover and other seeds will enable one to tell where they were grown.

Burchard, in his account published in a contribution from the Seed Control Station of Hamburg, states that a large number of seeds investigated by him had impurities. Of two hundred and eighty seeds tested, one hundred and sixty-seven belonged

1 Handbuch der Samenkunde.—Berlin. 631. 1876.
2 Landw. Vers. Stat. 13:233.
3 Die Pflanzenbaulehre.
4 Beiträge sur kenntniss der Samen Ackerunkrauter Ber. Oberhess.
5 Landwirtschaftliche Samenkunde—1:2:1362.
6 Deut. Landw. Presse. 1891. Landw. Vers. Stat. 41:42:45. Mitteil Bot. Lab. Samen Prufungs Anstalt Hamb. 3:6 4:19. The Object and Methods of Seed Investigation and the Establishment of Seed Control Stations, Expt. Sta. Record U. S. Dept. Agr. 4:798. 882 7f.

to the pulse family, seventy-nine to the grass family, twenty-three to forest seeds, and eleven were miscellaneous. He found the minimum purity of the clover seed was 54.2 per cent. The highest percentage of purity was found in timothy 99.42. The lowest germinative energy was found in fescue grass 0.17 per cent, and the highest in clover 97.25 per cent. Of the sixty samples of red clover examined for dodder, twenty-eight were free. The most common species was clover dodder, although others were also found. One lot of alfalfa from South America contained the Chilian dodder. In this investigation as in others, he emphasizes the importance of determining the kinds of weeds found in the seed, thus: In the Australian orchard grass the hairy brome grass was common, and in North American seed, orchard-grass, timothy, blue grass and tickle grass were common.

The work of Settegast [1] treats extensively on the subject of agricultural seeds and seed testing, especially with reference to vitality and seed production.

Vandevelde's [2] work treats of the morphology and physiology of germination and includes a splendid bibliography.

Attention should be called to the excellent contributions of Wollny [3] whose splendid work on seeds and care of agricultural crops, often gives considerable detail on the germination and viability of various agricultural seeds.

Kienitz [4] gives a detailed account of the methods to be followed in the study of germination of seeds.

Fruwirth carried out a study on the color and specific gravity of clover seeds. He found that the dark violet seeds were heavier than the light colored ones of the same head, and perhaps had greater germinative energy. [5]

Samek carried on an experiment, testing seeds for a period of eleven years, showing the results of germination after the first and eleventh years. [6]

There are many other contributions, but most of these papers will be found recorded in the literature cited by Vandervelde, Harz and Nobbe.

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1 Die landwirtschaftlichen Samereien und der Samenbau. Leipzig. 1892.
2 Die Kieming der zaadplanten Morphologie en Physiologie Gent. 1896.
3 Saat und Pflege, Der Landwirtschaftlichen Kulturpfianzen.
4 Ko'kwitz Ueber Ausfuhrung von Keimprobem, Forstl. Bl. 6:1 Bot. Centralbl. 1:52.
5 Landw. Vers. Stat. 1901:439. Centralbl. Agrl.-Chen. 31-108.
6 Exp. Sta. Rec. U. S. Dept. Agrl. 6:429.

AMERICAN WORK.

The pioneer work in this country was done by Profs. E. H. Jenkins and Warneke, of the Connecticut Agricultural Experiment Station. [1]

Later Gerald McCarthy, of the North Carolina Agricultural Experiment Station, published an elaborate paper on the subject [2] in which he gave the details of an extensive investigation carried on in North Carolina on germination of seeds.

Work in Michigan. Some excellent work was done by Prof. W. J. Beal, [3] in Michigan, who reported results of germination of clover seeds furnished by seedsmen. From seeds grown on moist paper the results of the germination showed that large red clover had a germination of 88 per cent, medium red clover 88 per cent, white clover 84 per cent and alsike clover 64 per cent. Prof. Beal called attention to the difference in germination of seeds when grown in sand and in blotting paper. From seeds grown in sand the following results were obtained: Medium clover had a germination of 76 per cent, white clover 92 per cent, red clover (two separate lots) 70 and 56 per cent.

A later report of Prof. Beal [4] gives two tests of twelve years old clover seeds in both of which the germination was 35.8 per cent.

Subsequent reports on the vitality of clover and other seeds were made. [5]

Prof. Beal also reports tests on seeds sent by farmers. Fifty-eight samples ranged from 25 to 97 per cent, seventeen being above 90 per cent. [6] Prof. Beal early called attention to the presence of rib plantain in clover seed.

Mr. Parsons in 1893 made some interesting tabulations in a summary of American seed vitality tests. [7] In the results offered by him we find the following: Alsike 72.7 per cent, crimson clover 59 per cent, red clover 84.8 per cent, mammoth clover 82.5 per cent, white clover 72.1 per cent, alfalfa 61.6 per cent.

Prof. Butz [8] studied many hundred samples of seeds, chiefly with respect to their germinative power. In many cases the percentage of germination was very low. Thus we find recorded the following: Alfalfa 52 per cent, alsike clover 61 per cent, Japan clover 69 per cent and seradella 13 per cent.

1 Ann. Rept. Conn. Bd. Agr. 1878:352; Jenkins Conn. Agr. Exp. Sta. 1879:93. 1883:96; Ann. Rept. Bd. Agr. 12:227.
2 Bull. N. C. Agr. Exp. Sta. 108:345.
3 Rept. Mich. Bd. Agr. 1884:232. Society Prom. Agr. Sci. 1884:14, 1889:15, 1894:283. Rept. Mich. Bd. Agr. 1894:442, 1888:142, 74.
4 Agr. Sci. 8:284. 1894.
5 Proc. Soc. Prom. Agr. Sci. 20:86-87. 1899, 26:89-92. 1905.
6 Rept. Mich. Bd. Agr. 16:390-391.
7 Agr. Sci. 7:541.
8 Rept. Pa. Agr. Exp. Sta. 1887:20, 1889:162; Bull. 4:8-10.

Work in Ohio. Mr. Devol [1] early recognized and emphasized the importance of the experiment station in studying the vitality of seeds. In tests conducted by him clover showed a germination of 93 per cent.

Later Selby and Hicks [2] made a study of fifty-two samples of clover and alfalfa seeds sold in Ohio. They found not only that the seeds had a low vitality but that they contained considerable impurities.

Work in Nevada. Several very important papers were published by Mr. Hillman on clover seeds and their impurities. One of his earlier bulletins deals with the descriptions of weed seeds and their distribution, together with an incidental account of the occurrence of these seeds in commerce. In a later publication he considers the weed seeds found as impurities in various types of seeds, including alfalfa, red clover, white clover, alsike clover, crimson clover, Japan clover, Bokhara clover, yellow trefoil and esparcette. In his investigations a large number of samples was examined. The paper therefore gives a fair estimate of the impurities generally found in the various clover seeds offered for sale in this country. [3]

Work in Kansas. Prof. Roberts and Mr. Freeman carried on an extensive investigation of alfalfa seed, showing adulteration, substitutes and impurities; and the methods of detecting the latter. They found some adulteration in alfalfa seed. [4] The yellow trefoil (*Medicago lupulina*) was most frequent though there were occasional instances in which burr clover (*Medicago denticulata*) and sweet clover (*Melilotus alba*) occurred. The most noxious weed seeds found were the docks and the English plantain. The average germination of alfalfa seed was 83 per cent.

Work in Maine. Prof. Harvey and other members of the staff of the Maine Experiment Station [5] investigated the vitality and the impurity found in the agricultural seeds offered for sale in that state. The results of Prof. Harvey's investigations disclosed the advisability of having a law to regulate the sale of seeds. Such a law was passed by the state of Maine and the work of carrying on this line of investigation and the enforcement of the law was placed in the hands of the director of the Station.

The results of the tests and regulations concerning the seed

1 Rep. Ohio Agr. Exp. Sta. 1:113, 2:149, 6:283.
2 Bull. Ohio Agr. Exp. Sta. 142:111-130; 4pl.
3 Bull. Nev. Exp. Sta. 38:1-124; 47:1-90.
4 Bull. Kans. Agr. Exp. Sta. 133:51-111, 33pl.
5 Rep. Maine Agr. Exp. Sta. 1887:149-160; 1888:136; 1889:150-160; 1890:107-112; 1891:186; 1896:113, 181.

testing for Maine were published by Charles D. Woods, director of the Station. [1]

Work in Kentucky. Prof. Garman and others, of the Kentucky Experiment Station, have investigated the impurities in grass and other forage plants sold in Kentucky. It was found that thirty-six of the five hundred and fifteen samples examined were adulterated; among these were red clover, blue grass, timothy and orchard grass. They concluded that the greatest fraud perpetrated is in the sale of certain varieties under an assumed name. [2]

Kentucky now has in consequence of this work an admirable law forbidding adulteration or misbranding of the clovers and timothy sold for seed in the state. Its effects have been most salutary and have been studied with profit by other commonwealths.

Work in Vermont. Prof. L. R. Jones, of the Vermont Experiment Station, made an examination of thirty-four samples of clover seed sold in Vermont. [3] He reports the total percentage of impurities in red clover as being from .3 to 5.3, with an average of 1.8 per cent; alfalfa as having a maximum of 7.1 per cent and a minimum of .6 per cent. Sorrel was found in 60 per cent of the red clover samples and wild carrot in a few, the rib plantain occurred in 77 per cent, dodder in 5 per cent and Canada thistle in 5 per cent. Dodder did not occur in the alfalfa, but in 8 per cent of the samples Canada thistle was found.

Work of the United States Government. The National Government began a serious investigation of agricultural seeds and their impurities in 1893. Early articles on the subject appeared under the head of "Pure Seed Investigation." [4]

Mr. Hicks called attention to the abuses in the seed trade. The matters that were mentioned by him have evidently not been remedied since 1894. Since then the work of the Department has been immeasurably increased, especially by such contributions as have been made by Mr. Duvel on the vitality of buried seeds and the storage and germination of wild rice; and the paper by Mr. Pieters on "The Farmer's Interest in Good Seed." Among the notes on seed testing in 1897, Prof. Hicks and Mr. Sothoron Key published an account of the germination of several forage plants and flower and garden seeds. [5]

A good table on the percentage of germination standards required of seeds will be found in a paper by Mr. Pieters. These

1 Rep. Maine Agr. Exp. Sta. 13:32; Bull. 1. c. 36, also Inspection Laws
2 Bull. Kentucky Exp. Sta. 127:128-169.
3 Rep. Vermont Agr. Exp. Sta. 11:229.
4 Yr. Bk. U. S. Dept. Agr. 1894:389. 1895:175.
5 Bull. U. S. Dept. Agr,, Bureau Plant Industry 83; Bull. Plant Industry 90; Far. Bull. U. S. Dept. Agr. 111; Yr. Bk. U. S. Dept. Agr. 1897:44

seed standards were also published in the Year Book of 1896. Later Mr. Pieters discussed the presence of clover dodder and other impurities in clover seed. [1] In a circular by Prof. Dewey of the same division the dodders found in clover were discussed. [2]

In a paper by Brown and Hillman, "The Seed of Red Clover and its Impurities," the more important impurities found in European and American grown clover seed are given. Attention is called to the introduction of bad seeds from Chili. In 1905 two hundred and seventy-five thousand pounds of Chilian red clover seeds were imported into the United States, and this clover seed contained Chilian clover dodder seed. This dodder may prove to be a destructive clover parasite in the United States. Mr. Brown, in a paper on legal and customary weights per bushel of seeds, has also brought together much important matter on the subject of the weight of commercial seeds. [3]

The quality of the seed, especially its germinative energy, depends somewhat on the manner in which seeds are kept. Two articles on this subject are of special interest in this connection, one by Pieters, "Agricultural Seeds, Where Grown and How to Handle," and an article by Pieters and Brown, "Kentucky Bluegrass Seed, Harvesting, Curing and Cleaning." [4]

The United States Department of Agriculture has published rules and described apparatus for seed testing. These were adopted by the standing committee on seed testing of the Association of American Agricultural Colleges and Experiment Stations. [5]

Canadian Work. In 1892 Prof. J. H. Panton called attention to the importance of making an investigation of seed purity and of carrying on a campaign for better and cleaner seed. He thought a large number of the weeds on the Ontario farms were introduced in clover seed. [6]

He found the number of weed seeds varied greatly, all the way from one to four thousand five hundred and forty per half ounce. Among the weed seeds he reported several that have become troublesome in the Mississippi Valley; these include ribgrass and chicory.

Saunders [7] in several reports of the Experimental Farms has discussed the vitality of grass and clover seeds. In 1903 there were tested one hundred and eighty-six samples of clover; the highest percentage of germination being low, the lowest 17 and the average 76.3. A large number of grass seeds were also tested.

1 Yr. Bk. U. S. Dept. Agr. 1895:175. Yr. Bk. U. S. Dept. Agr. 1896:623;
2 Cir. Div. Bot. U. S. Agr. 24; Far. Bull. 123; Cir. Div. Bot. U. S. Dept. Agr. 14.
3 Far. Bull. U. S. Dept. Agr.; 260; Bull, Bur. Pl. In. 51, part 5.
4 Yr. Bk. U. S. Dept. Agr. 1901:233; Bull. Bur. Pl. In. 19.
5 U. S. Dept. Agr. Exp. Sta. Cir. 34.
6 Bull. Ontario Agr. Coll. 98:8; Rept. Ontario Agr. Coll. and Exp. Farm
7 Rept. Exp. Farms Canada 1893:29; Rept. Exp. Farms Canada 1904:16.

Since 1903 the Department of Agriculture of the Dominion of Canada has created a seed division with Mr. G. H. Clark in charge of the work in purity and vitality tests.

STANDARDS OF PURITY AND VITALITY.

In a study of our agricultural seeds two questions are of paramount importance, first that of impurities, second that of vitality. A large number of investigations which may serve as a basis for standards of purity and vitality in seeds have been made in Europe and in this country. The European requirements at least so far as vitality is concerned are somewhat higher than in this country. The more important seed standards published by the United States Department of Agriculture are as follows: [1]

PER CENT OF PURITY AND GERMINATION OF SEEDS.

Seed	Purity	Germination
	Per cent	Per cent
Alfalfa	98	85-90
Barley	99	90-95
Blue grass, Canadian	90	45-50
Brome, awnless	90	75-80
Buckwheat	99	90-95
Clover, alsike	95	75-80
Clover, crimson	98	85-90
Clover, red	98	85-90
Clover, white	95	75-80
Corn, field	99	90-95
Corn, sweet	99	85-90
Fescue, meadow	95	85-90
Kaffir corn	98	85-90
Millet, common	99	85-90
Millet, hog	99	85-90
Millet, pearl	99	85-90
Oats	99	90-95
Rape	99	90-95
Rye	99	90-95
Sorghum	98	85-90
Timothy	98	85-90
Wheat	99	90-95

Mr. C. L. Parsons has compiled data of tests made on the germination and impurities found in a large number of seed tests carried on in this country prior to 1893. He gives the averages of some as follows: [2]

1 Yr. Bk. U. S. Dept. Agr. 1896:623.
2 Agr. Sci. 6:541.

Seed	Vitality	No. of Sample	Impurities	No. of Sample
Alfalfa	61.6	16	.39	6
Barley	80.	6	...	1
Blue grass	6.3	42	3.3	5
Blue grass, Canadian	11.	1	...	0
Corn, field	89.	993	...	0
Corn, sweet	83.1	118	5.53	17
Clover, Bokhara	63.	4	.5	1
Clover, crimson	59.	5	3.52	2
Clover, Alsike	72.7	16	1.29	2
Clover, red	84.8	74	2.73	55
Clover, mammoth	82.5	4	1.	2
Clover, white	72.1	15	3.86	3
Red top	34.2	30	51.7	6
English rye	63.2	14	6.8	4
Fescue, meadow	66.3	11	3.97	2
Hungarian grass	59.3	11	.32	3
Oats	96.5	57	.28	6
Orchard grass	59.9	18	12.6	10
Meadow foxtail	15.	5	6.2	1
Rye	98.	3	...	3
Tall meadow oat grass	42.7	7	7.38	2
Wheat	94.6	292	.46	4

The Illinois Agricultural Experiment Station [1] reported on the condition of the poor grass seed found upon the Illinois market, especially that of Kentucky blue grass, red top and timothy. Each of seventeen samples was purchased on the market and from different seedsmen. The average for the seventeen samples tested in a Geneva germinator was as follows: Blue grass 2 per cent, red top 25 per cent and a little more than 76 per cent for timothy. However, all duplicate samples tested in the greenhouses and open air showed somewhat better conditions as will be seen from the following table.

TABLE SHOWING NUMBER AND PERCENTAGE OF KENTUCKY BLUE GRASS SEED SPROUTING WHEN SOWN IN SOIL IN THE OPEN AIR AND IN THE GREENHOUSE.

No. of Sample	No. of Seeds Sprouted of One Gram Sown		Per Cent. of Seeds Germinating	
	Open Air	Greenhouse	Open Air	Greenhouse
1	776	490	16.1	10.2
2	1,689	964	35.2	20.1
3a	1,032	537	21.5	11.2
3b	1,636	931	34.1	19.4
4	1,429	1,099	29.8	22.9
5	1,349	762	28.1	15.9
6	674	735	14.	15.3
7	484	396	10.1	8.3
8	1,320	1,090	27.5	22.7
9	1,105	832	23.	17.3
10	791	351	16.5	7.3
11	1,148	335	23.9	7.
12	913	696	19.	14.5
13	1,263	255	26.3	5.3
14	368	121	7.7	2.5
15	813	341	16.9	7.1
16	798	291	16.6	6.1
17	1,304	586	27.1	12.2
18	2,316	2,750	48.3	57.2

1 Bull. III. Agr. Exp. Sta. 15:47. 1891.

It will be seen that the vitality is very low in numerous cases and this is attributed to the method in which the seed is collected. They often heat and become mouldy and thus the seeds are destroyed.

Sample No. 18 was Experiment Station seed gathered on the Station grounds in Urbana, and should have been good seed. The same Station subsequently made tests of home-grown seed of Kentucky blue grass and comments on these as follows:

The first tests made upon the vitality of Kentucky blue grass led to correspondence with all the seedsmen whose seeds were tested. It was stated by them that it is the practice to cut or strip Kentucky blue grass for seed while quite green as more and cleaner seed could be obtained that way, but in curing often heats and spoils. It was decided to verify this statement and the following table gives the results obtained:

TABLE SHOWING THE VITALITY OF HOME GROWN KENTUCKY BLUE GRASS SEED CURED IN DIFFERENT WAYS.

Condition of Gathering and Keeping the Seed	No of Seeds Sprouted in a Gram			No. of Seeds in a Gram as Sown	Per cent of Seeds Sprouting
	a	b	Average		
Gathered green and dried on floor in a dry room	2,994	2,737	2,868	3,954	72.5
Gathered green and dried in cellar	2,976	2,768	2,872	4,014	71.6
Gathered green and dried in grain sack	3,040	2,970	3,005	4,127	72.8
Gathered ripe and dried on floor in a dry room	3,069	2,851	2,960	3,695	80.1

The percentage of seeds sprouting in the three samples gathered green were practically alike, the average being a little more than 72 per cent; while that of the ripe seed was somewhat higher, being 80 per cent.

Messrs. A. J. Pieters and Edgar Brown [1] in a paper on Kentucky blue grass seed found a great variation in the germination. Twenty-one average samples taken from large lots of seeds were cured in the ordinary way, six of them germinated twenty-five per cent or less and were worthless as commercial samples, while only nine germinated over seventy-five per cent, and would be graded as first-class seed. The other six samples, germinating from thirty-five per cent to sixty-nine per cent, would be considered poor to fair.

The following table by Pieters and Brown shows how rapidly blue grass deteriorates if not taken care of properly.

1 Bull. U. S. Dept. Agrl. Bur. Pl. Ind. 19.

SEED STRIPPED JUNE 18; PUT IN RICK ON GROUND JUNE 18, 6 P. M.

Sample	When Taken	Temperature Degrees F.	Part of Rick	Percent of Germination
a	June 19, 2 p. m.	148	Inside	3
b	June 19, 2 p. m.	.....	Top	91
c	June 20, 10 a. m.	142	Inside	.5
d	June 20, 6 p. m.	132	Inside	.5
e	June 20, 6 p. m.	.....	Top	1.5
f	June 21, 10 a. m.	104	Inside	.5
g	June 21, 10 a. m.	153.3	Inside	.5

The outside seeds germinated well. The others were practically worthless. In sixteen hours the seed was totally destroyed by fermentation. Much of the seed sold is not as carefully prepared as it should be.

The standards of the United States Department of Agriculture may be compared with the following guarantee offered by some of the seed merchants in Europe. It will be seen from the table that they offer a much higher percentage of vitality than we require in this country. The quality of our commercial seeds can be greatly improved by insisting upon a higher percentage of purity and viability. [1]

	Purity.	Vitality.
Agrostis stolonifera, creeping bent grass	96	88
Alopecurus pratensis, meadow foxtail	85	70
Avena flavescens, yellow oat grass	96	42
Arrhenatherum avenaceum, tall meadow oat grass	74	72
	90	75
Dactylis glomerata, orchard grass	59	78
Festuca pratensis, fescue grass	95	92
Lolium Italicum, Italian rye grass	97	80
Lolium perenne, English rye grass	98	93
Medicago sativa, alfalfa	97	90
Medicago lupulina, black seed hop clover	99	62
Phleum pratense, timothy	99	97
Trifolium arvense, stone clover	98	93
Trifolium hybridum, alsike clover	94	70
Trifolium pratense, red clover	96	95
Trifolium repens, white clover	96	93

In our own investigations five samples of clover had a vitality of 100 per cent, based on germination of plump seed. One sample had a vitality of between 95 and 100 per cent, one of timothy 98 per cent. These facts show that some samples of clover seed and timothy of the best possible vitality were offered to the Iowa farmer and that seeds of good quality can be obtained. The average recorded by Prof. Holden [2] from eight hundred samples of corn was 80 per cent, however, nearly 22 per cent of this showed a weak germination.

1 Seed Testing: Its Uses and Methods. Bull. North Carolina Exp. Sta., 108:360a.

2 Bull. Ia. Col. Exp. Sta. 77; Dec., 1905.

RESULTS OF SEED STUDIES FOR 1906 AT IOWA STATION.

SCOPE OF WORK.

During the year 1906, four hundred and thirteen samples of the seeds of various forage plants were examined, particularly those of red clover, white clover, alsike clover, alfalfa, timothy, blue grass, rape and some wheat. In this Bulletin, however, we shall only consider the seeds of the clovers, alfalfa and timothy because the others were not of sufficient numbers to warrant general conclusions.

The impurities found in various agricultural seeds vary with the locality and kind grown. Attention has been called to the works of Dr. Burchard in which he states that the character of impurities found in clover seed will enable one to determine their origin.

The common impurities found in wheat, in Iowa, are corn cockle, vetch, chess, mustard and occasionally poison darnel. Oats commonly contain wild oats, rag weed, mustard, and so on. Grass seeds contain various impurities; the fescue grass contains such impurities as sheep's fescue and quack grass; orchard grass frequently contains such impurities as fescue, sour dock, field sorrel, curled dock and velvet grass. In blue grass such impurities as dock, field sorrel, horse nettle, cinquefoil, pepper grass, hair grass and Canadian blue grass occur. Timothy contains such impurities as pepper grass, green foxtail, blue grass, witch grass, alfalfa, ribgrass, charlock and bracted plantain. Timothy is, however, quite clean as compared with other grass seeds although pepper grass is of frequent occurrence. Alfalfa contains many bad seeds as impurities, of these weeds dodder, curled dock, Canada thistle, pepper grass, burr clover and sweet clover may be mentioned. Flax seed contains, as one of the important impurities, mustard, both black and charlock. Much of the mustard in our Iowa fields today is due to the flax cultivated there many years ago.

METHODS OF INVESTIGATION.

During the spring of 1906 the Station received, in response to a notice placed in several agricultural papers in the state, a large number of clover samples and seeds of other forage plants. There were two hundred and thirty-eight samples of clover seed from seventy-two counties, six samples of white clover seed from two counties, twenty-four samples of alfalfa from twelve counties, thirty samples of timothy from twenty-five counties and eighty-nine samples of alsike clover from thirty-six counties. The map shows the distribution of samples in Iowa. (Fig. 1).

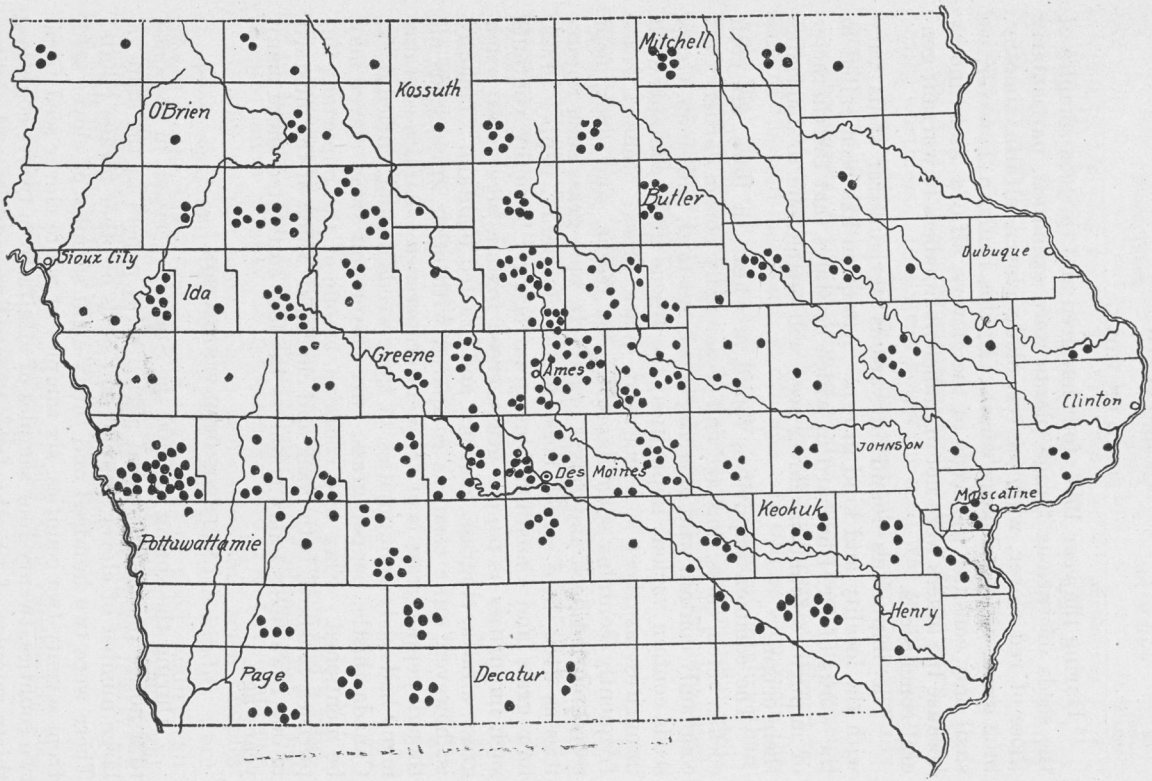


FIG. 1. LOCALITIES FROM WHICH SEED SAMPLES WERE RECEIVED.

The samples sent were in general small and consequently we were unable to determine definitely whether or not they were average samples. Presumably they were, in many cases, as the seedsmen in several instances offered to take the seeds back and send other seeds, owing to adverse reports submitted to the farmers. The small dealers selling the seed to farmers were quite as anxious to dispose of good seeds as the farmers were to purchase them. The farmers and seed merchants were unable, of course, to supply much in the way of data that would have been of value in determining the origin and history of the seeds. In the future, however, even more careful efforts will be directed toward making these data more complete. The following card is used to record these facts and in the future work of this character is to be filled out by the sender.

DATA IN REGARD TO SEED.

Kind of seed
Name of sender
Address of sender
From whom purchased
Address of seller
Cost of seed per bushel ..... Per 100 lbs. .....
Grade for which offered
When grown
Where grown
Remarks .....
(Address Botanical Section, Exp. Sta., Ames, Iowa).

The following tables show the records kept by the Station in regard to vitality and the amount of impurities. These cards are kept on file for future reference.

RECORD OF SEED TEST.

(Front of card.)

Sent by..... Kind..... No.....

Address ..... Where grown.....

Date received....., 190.. Date of test....., 190.. Grams used.....

Pure seed %.... Inert Matter.... Foreign Seed.... Total Impurities....

Test made by..... Cost of seed.....

LIST OF IMPURITIES.

	No.	%		No.	%
.....					
.....					
.....			Per cent plump, mature seed		
.....			Per cent immature seed		
.....					

Remarks .....

Seed firm..... Address .....

(Back of card.)

VITALITY.

Soaked.....

Date of test..... Test made by.....

Seed bed ..... No. of seeds.....		1	2	1	2	1	2	1	2
1st day.....									
2nd day.....									
3rd day.....									
4th day.....									
5th day.....									
6th day.....									
7th day.....									
8th day.....									
Duration of Test	per cent.....								
	average per cent.....								
No. hard at close of test.....									
Total Germination	per cent.....								
	average								
Temperature									

RED CLOVER. (*Trifolium pratense*).

A large number of studies have been made of clover seed and its impurities, and in this connection attention should be called to the papers of Hillman, Nobbe, Hicks, Selby, Jones and Harvey, papers that have been referred to elsewhere in this Bulletin.

DESCRIPTION. Seeds of red clover are longer than broad; varying in length from 1-16 to 1-10 of an inch; the average being about 1-12. In shape they are roughly triangular, with angles rounded and no two sides equal in length. The sides of the seed are somewhat convex with rounded edges. The scar or hilum is near the end of the radicle which does not project as prominently as in some other clovers. In color the seeds are light yellow or purple, although some individual seeds are yellow and purple; some seeds shade off to violet. The old seeds are more brownish. Among the plump seeds occur many that are immature; they are shrivelled and are usually of a brownish color. The seeds of the mammoth clover and red clover are much the same, being practically indistinguishable, but the mammoth is usually larger. Unhulled clover seed pods are common in clover seed; each pod contains a single seed; and seeds with a portion of pod remaining are also frequent. In seeds that are cracked one may frequently see the plumule lying between the cotyledons.

ADULTERATION. Investigations carried on in Europe and in this country have shown that red clover seed is not infrequently adulterated. The adulteration consists either of crushed quartz

and other rocks or sand sometimes colored to resemble the clover seed, or of old and worthless seeds frequently dyed mixed with fresh seed. On this point Brown and Hillman [1] say:

"Sample No. 1, imported at five and one-fifth cents per pound, contained about 18¼ per cent of red clover seed that would grow, and most of this was small, light seed that would not produce vigorous plants. Large quantities of seed of this grade are constantly being imported. The quality of such seeds is so poor that it is not often sold alone; neither is it recleaned, as the good seed it contains actually costs more than the best quality of seed. None of this poor seed is imported to be wasted, but it is mixed in varying proportions with better seed and sold to the farmer.

"Sample No. 2, contained more than 95 per cent of red clover seed that would grow, and was practically free from weed seeds. In order to sow the same amount of good seed from these samples, it would be necessary to sow 5¼ pounds of the poor sample to one pound of the other. Every time 150 weed seeds were sown with the good sample, 733,567 weed seeds would be sown with the poor one."

We have strongly suspected in our work that some of the red clover seed sold on the market last year was old. In fact, the low vitality shown in some of our germination tests would seem to indicate that old and worthless seeds were sold. Although many of the poor germination tests were undoubtedly due to entire samples being old and to immaturity and poor quality of much of the clover seed of 1905, yet it is believed that the erratic results reached in some instances justify the conclusion that old seed, of good appearance, had been mixed with the new seed, the latter often immature and shrunken. Not infrequently where there was a considerable percentage of shrunken seed the germination was much better in this than in the plump seed. Seed of the same age would not frequently give results of this nature.

Impurities. A large number of studies has been made on the subject of impurities found in clover seeds. Some quite exhaustive studies were made by Prof. Hillman, quoted elsewhere in this Bulletin and also by Mr. Stewart. Prof. Hillman's samples were obtained from dealers in different parts of the country. For the sake of comparison with the results of our own investigation we quote the following table from Prof. Hillman:

1 Farmers Bull. U. S. Dept. of Agrl. 260:6.

REPORT UPON THE EXAMINATION OF 70 SAMPLES OF RED CLOVER SEED FROM VARIOUS PARTS OF THE U. S.

Kind of Seeds Found and Per Cent of Samples Containing Them.

Rugel's Plantain (*Plantago Rugelii*)	80.	Smartweed (*Polygonum Hydropiper*)	7.1
Green Foxtail (*Chamaeraphis viridis*)	64.3	Pepper grass (*Lepidium intermedium*)	5.7
Lady's Thumb (*Polygonum Persicaria*)	62.9	Canada Thistle (*Cnicus arvensis*)	4.3
Lamb's Quarter (*Chenopodium album*)	55.7	Bull Thistle (*Cnicus lanceolatus*)	4.3
Rib Grass (*Plantago lanceolata*)	52.9	Field Dodder (*Cuscuta arvensis*)	4.3
Curled Dock (*Rumex crispus*)?	52.9	Wild Carrot (*Daucus carota*)	4.3
Yellow Foxtail (*Chamaeraphis glauca*)	42.9	Ciliate-leaved Paspalum (*Paspalum setaceum*)	4.3
Sorrel (*Rumex Acetosella*)	42.9	Chess (*Bromus secalinus*)	2.9
Large Spotted Spurge (*Euphorbia nutans*)	41.4	Horse-Mint (*Monarda sp.*)	2.9
Bracted Plaintain (*Plantago aristata*)	38.6	Evening Primrose (*Oenothera biennis*)	2.9
Timothy (*Phleum pratense*)	38.6	Willow-leaved Dock (*Rumex salicifolius*)	2.9
Witch Grass (*Panicum capillare*)	34.3	Black Night Shade (*Solanum nigrum*)	2.9
Smooth Crab Grass (*Panicum glabrum*)	34.3	Pimpernel (*Anagallis arvensis*)	1.4
Crab Grass (*Syntherisma sanguinalis*)	32.9	Corn Chamomile (*Anthemis arvensis*)	1.4
Tumble Weed (*Amarantus albus*)	31.4	Yellow Rocket (*Barbarea vulgaris*)	1.4
Alsike Clover (*Trifolium hybridum*)	24.3	Black Mustard (*Brassica nigra*)	1.4
Rough Pig Weed (*Amarantus retroflexus*)?	22.9	False Flax (*Camelina sativa*)	1.4
Self heal (*Brunella vulgaris*)	20.	Sedges (*Carex spp.*)	1.4
Fox Tail (*Chamaeraphis verticillata*)	18.6	Larger Mouse-ear Chickweed (*Cerastium valgatum*)	1.4
Catnip (*Nepeta Cataria*)	15.7	Chicory (*Chichorium Intybus*)	1.4
Night-flowering Catchfly (*Silene noctiflora*)	15.7	Candy Grass (*Eragrostis major*)	1.4
Vervain (*Verbena sp.*)	15.7	Spurge (*Euphorbia sp.*)	1.4
Blue Vervain (*Verbena hastata*)	14.3	Dwarf Mallow (*Malva rotundifolia*)	1.4
Mayweed (*Anthemis Cotula*)	12.9	White Hoarhound (*Marrubium vulgare*)	1.4
Common Plantain (*Plantago major*)	11.4	Corn Mayweed (*Matricaria inodora*)	1.4
Bitter Dock (*Rumex obtusifolius*)	11.4	Meadow Foxtail (*Alopecurus pratensis*)	1.4
Ragweed (*Ambrosia artemisiaefolia*)	10.0	Yellow Trefoil (*Medicago lupulina*)	1.4
Barnyard Grass (*Panicum Crus-galli*)	10.0	Orchard Grass (*Dactylis glomerata*)	1.4
Prickly Sida (*Sida spinosa*)	10.0	Wood Sorrel (*Oxalis stricta*)	1.4
White Clover (*Trifolium repens*)	10.0	Field Paspalum (*Paspalum laeve*)	1.4
Knot Grass (*Polygonum aviculare*)	8.5	Five Finger (*Potentilla Monspeliensis*)	1.4
Turnip (*Brassica campestris*)	7.1	Bulrush (*Scirpus sp.*)	1.4
Wild Pepper Grass (*Lepidium Virginicum*)	7.1	Campion (*Silene sp.*)	
Panic Grass (*Panicum sp.*)	7.1	Cow-herb (*Saponaria vulgaris*)	

One hundred and thirty samples of red clover seeds were examined in the laboratory and the percentage of impurities determined by weight. The following tables summarize the data which were obtained through this investigation, but for the sake of convenience only twenty-six of the most common weeds are included. It will be noted that timothy is included among the weed seeds although undoubtedly in many instances there was no intentional admixture.

OCCURRENCE OF IMPURITIES IN 130 SAMPLES OF CLOVER SEED IN PERCENTAGE BY WEIGHT

Number of Sample	Percentage of Impurities	Rough Pigweed	Lamb's Quarter	Canada Thistle	Bull Thistle	Dodder	Wild Carrot	Spurge	Evening Cockle	Old Witch Grass	Barnyard Grass	Smooth Crab Grass	Crab Grass	Timothy	Bracted Plantain	Rib Grass	Rugel's Plantain	Lady's Thumb (Smartweed)	Field Sorrel	Curled Dock	Yellow Foxtail	Green Foxtail	Night-flowering Catchfly	Starry Campion	Alsike Clover	White Clover	Mustard	Other Weed Seed	Sand and Dirt
1	1.948															1.91	.038												
2	1.469															.31	.04	.07	.073	.363	1.2		.724						
3	1.31												.065	1.843				243										.07	.128
4	2.349													.248				.052	.048			1.99							1.76
5	4.102		.0048														.01			.024		.213							
6	.247													58			.12	.08											
7	.82		.04																		.2								
8	.2												.25	.03						.1	1.23							.65	
9	2.277		.017																									.17	
10	.706										.075	.39	.071				07		.232	.084	.43							.45	
11	5.46		.054											4.04							.491						.283	.49	
12	1.264															.042					.141	.141			.211		07		
13	.605									.202				.056			.281										.056	.225	
14	.876										.22					.07	.14	.09		.35									
15	.97										.13			.088		.106	1.03	.26			.26							.26	
16	2.134													.01			.08	.03		.09		.06							
17	.29	.02																			.05						.2	.07	
18	.32												.037	.539			.064	.082		.085		.192					.512	.032	
19	1.543												.129			1.552						.155							
20	1.836													22.47	.237					.211							.156	9.586	
*21	33.296		.627										.71			.325		.253	.117			.455						2.79	
22	4.682	.031																				.19						3.9	
23	4.09												.125	.69			.42			.49								1.43	
24	2.87	.026													.077			.29		.29								2.3	
25	2.957																										.093	.066	
26	.159									.014				.72	.022		.53	.044	.22	.087	.022			16				.68	
27	4.438	.029		.029					.87	.012						.12	.109	.033	.408		1.3	.12					.207		
28	3.282	.024		.088																		.019						.28	
29	.895										.078		.14	.87				.21	.102	.064		.39	3.68	.044			.019	2.42	
30	.803				2.71									.72				.04		.005		.C05						2.01	
31	2.741														.009						.25	.26						.79	
32	1.31													.004	.024	.016	.016										.008	1.15	
33	1.219																										.019	.51	
34	.159	.024											.057	.26			.15				.057	.51							

*Large percentage due to timothy. This may have been a mixed sample not intended for pure clover.

OCCURRENCE OF IMPURITIES IN 130 SAMPLES OF RED CLOVER SEED IN PERCENTAGE BY WEIGHT

Number of Sample	Percentage of Impurities	Rough Pigweed	Lamb's Quarter	Canada Thistle	Bull Thistle	Dodder	Wild Carrot	Spurge	Evening Cockle	Old Witch Grass	Barnyard Grass	Smooth Crab Grass	Crab Grass	Timothy	Bracted Plantain	Rib-grass	Rugel's Plantain	Lady's Thumb (Smartweed)	Field Sorrel	Curled Dock	Yellow Foxtail	Green Foxtail	Night-flowering Catchfly	Starry Campion	Alsike Clover	White Clover	Mustard	Other Weed Seed	Sand and Dirt
35	.609		.19							.22			.29	.29	.296	.65	.81	.18		.035	.022	1.73						.166	1.14
36	2.623							.012					.31	.68			.012	.054				.29						.024	1.24
38	1.348					.052								3.76	.394		.02	.02											2.05
39	.2	.016											.009	.052			.3											.052	.048
40	1.527							.012					.027	.008		.008		.032	.027	.004		.028							.036
41	3.942	.015												.105		.03	.06	.015	.037	.03		.09		.015				.015	1.13
42	.125		.011										.022	.72	.044	.011	.057	.033		.12	.025	.033						.01	3.5
43	3.705		.048		.042												.011	.011		.049									.044
44	1.548											.014		1.007		.014		.009		.036		.760		.028				.009	1.710
45	3.4		.015							.054				.087						.058									1.403
46	5.289			.001		.001							.015	.610	.027	.51	.76	.043	.045	.013		.908							.42
47	3.582	.01	.66													3.209						.058						.120	1.89
48	2.804	.009	.018					.004		.36				.850	.048	.027	.054				.043	1.89							
49	1.242													.33	.028	.018	.501	.042	.014	.12		.51						.009	1.165
50	2.54													.059			.019		.053			539							.572
51	.978																	.199				1.853							.488
52	1.588	.011												.933								.029						.008	.008
53	1.025	.005	.005							.011				1.104			.022	.011	.011	.049	.011	.071							.298
54	1.144													.028		.017	.011	.011		.034	.005	.017							.881
55	7.788				.041	.041								.05		.037	.037					.043							.977
56	5.10				.02									.623		.649	.025	.034		.461		1.494		.825					3.595
57	5.023		.006		.012			.006				.006		.257		.03	.02			.015		.03							.138
58	2.953	.032		.024						.016			.008	.042		.304				.036	.444	1.846		.164					2.157
59	1.191			.035				.009					.009	.886	.016	.032	.04		.469	.016	.072	.634						.048	.660
60	.660									.2			.005	.362		.009	.014	.098	.018	.023	.009	.126							.479
61	9.26													.005							.01	.03							.59
62	.474													2.221		.009					1.241							.013	5.776
63	.496																.008												.466
64	5.838	.076							.402		.143	.038		.001		.099			.033		.094					.018			.241
65	1.461											.039		.256			.043		.076	.105	.494	.140						.009	1.945
66	4.268							.088		.02	.102	.072		.318		.348	.129	.149	.179			.202							.097
67	2.998	.018		.084								.102	.034	.698							1.183	1.044							1.061
68	1.737	.012												.846			.222				.218	.252						.366	.856
														.211		.012	.02	.008	.298			.626		.07				.006	.476

OCCURRENCE OF IMPURITIES IN 130 SAMPLES OF RED CLOVER SEED IN PERCENTAGE BY WEIGHT

Number of Sample	Percentage of Impurities	Rough Pigweed	Lamb's Quarter	Canada Thistle	Bull Thistle	Dodder	Wild Carrot	Spurge	Evening Cockle	Old Witch Grass	Barnyard Grass	Smooth Crab Grass	Crab Grass	Timothy	Bracted Plantain	Rib Grass	Rugel's Plantain	Lady's Thumb (Smartweed)	Field Sorrel	Curled Dock	Yellow Foxtail	Green Foxtail	Night-flowering Catchfly	Starry Campion	Alsike Clover	White Clover	Mustard	Other Weed Seeds	Sand and Dirt
69	.549		.727		.12									2.067		.159	.149					1.033						1.72
70	6.906													.208		.114		.104	.096	.104	2.228	2.106						1.136
71	6.363		.067	.071					.155		.13			.134	.05	.201	.037	.06	.079	.483	2.039	.471						1.836
72	3.326											.126		.319					.024		.124	.307						2.426
73	3.35	.014							.059		.059			.574	.047	.047		.059	.180	.043	1.608	1.164						1.890
74	2.034													.144														
75	1.254										.103					.083					.071						.041	.956
76	.81	.017						.061		.013				.015		.055	.586			.055								
77	.299	.033										.022									1.048	.472						1.413
78	3.41											.079		.48		.081		.101			1.075	.206						1.46
79	18.606		.165					2.649		4.63			3.659	2.882			.185										.111	4.327
80	1.09									.01				.272		.04	.03	.05	.068		448							.168
81	6.031					.066			.064			.018		2.424		.157	.21		.024	.069	.432						.338	2.223
82	4.049			.061					.048				.909	.669	.056	.278	.147	.202	.094	.051	.872							.405
83	3.95		.041		.134									.761					.041		1.567	.525					.236	.19
84	3.004					.007								.426		.05					.64	1.136					.359	.386
85	1.343													.053							.148							1.142
86	1.211	.019												.019			.024											1.149
87	2.885	.052							.175	.022	.11			.573			.155		.112		.377	.449						.882
88	2.754										.071		.065	1.316					.019	.208	.411	.459					.078	.215
89	7.187								.043	.037		.039	.082	1.88		.048	.089	.063	.067	.086	.522	.912				1.002		.021	2.292
90	2.744													2.22							.28	.092			.292				
91	1.835	.084	.06											1.4							.15							.075	.066
92	3.183													1.9		.103					.19								.99
93	5.764													.396					.217		.203	2.435			.237			.296	1.98
94	.27													.09			.18												
95	.34																.29					.05							
96	2.468															.142	.178	.071	.177	.059	1.77							.071	
97	.475																.11		.025	.22		.12							
98	2.187									.004	2.035						.020			.049	.0116								.0122
99	6.585													.777	1.606	3.01												1.554	1.36
100	11.7													7.						3.1									1.6
101	6.175													4.1				.033	.04									.0016	2.
102	Pure																												

OCCURRENCE OF IMPURITIES IN 130 SAMPLES OF RED CLOVER SEED IN PERCENTAGE BY WEIGHT

Number of Sample	Percentage of Impurities	Rough Pigweed	Lamb's Quarter	Canada Thistle	Bull Thistle	Dodder	Wild Carrot	Spurge	Evening Cockle	Old Witch Grass	Barnyard Grass	Smooth Crab Grass	Crab Grass	Timothy	Bracted Plantain	Rib Grass	Rugel's Plantain	Lady's Thumb (Smartweed)	Field Sorrel	Curled Dock	Yellow Foxtail	Green Foxtail	Night-flowering Catchfly	Starry Campion	Alsike Clover	White Clover	Mustard	Other Weed Seed	Sand and Dirt
103	.694													3.2			.075	.074	.05			.05							.125
104	.61													3.		.3	.05												.31
105	.78																												.34
106	8.028	.69			.069				2.1					.69	.069		.002	.69	.5	5.			.23					.05	.138
107	1.57	.04											.1	.18		.3	.2		.1		06	.5						.006	.05
108	.674												.043				.018		.037									.08	
109	2.692		.08										.08	.132		.085		.08	.15			.904	.36			.09	.080	.496
110	.455		.09																		.292	.073						.170	.59
111	1.75	.052								.032				.344		.043			.688	.144	.202	.159							.091
112	4.069	.072				.036				.036			.231	.76		.864				.253	.479	.942							.396
113	.1698												.174	.044	.0436	.21	.196		.604		.054	.087							.109
114	.822													.062			.038				.243	.475							
115	10.779			.707	1.04									1.207					.75	2.05	3.704	1.25					2.02	
116	1.13												.018	.657		.03					.03							.071	.327
117	1.411													.227			.046				.684	.454							
118	.553													.395							.017							.055	.103
119	.037															.02													
120	.487						.082							.135															.272
121	.682												.145						.107		.052								.525
122	1.294												.087	.234							.213	.03					.042	.688
123	.121												.033	.022					.066										
124	1.73												.098	.34			.17				.051	.033					.057	.824	
125	3.222		.464										.004	.537	.047		.014			.18	1.746					.049	.151		
126	1.854												.025	.309		.064	.237	.06	.073	.08	.733		.146				.061	.036	
127	8.799		.071			.05										.205	.17	.54		.079									
128	1.025	.024												.82		.042			.027			.035					.064	.045	
129	4.261												.085	.12				.055			.588								3.418
130	Pure																												

Average percentage of impurities in 130 samples of clover seed, 1.93 per cent.

In addition to the one hundred and thirty samples in which the percentages of weed seeds were determined by weight, one hundred and eighteen samples were examined without any determination being made of exact percentages. The following is a list of the weed seeds found in these samples and the number of times which they occurred.

WEED SEEDS IN 118 UNWEIGHED SAMPLES RED CLOVER. IOWA.

Name Weed Seed	No. Times Found	Percent Samples containg
Yellow Foxtail (*Setaria glauca*)	76	63.84
Timothy (*Phleum pratense*)	68	57.12
Curled Dock (*Rumex crispus*)	61	51.24
Green Foxtail (*Setaria viridis*)	57	47.88
Lady's Thumb (*Polygonum Persicaria*)	48	40.32
Rugel's Plantain (*Plantago Rugelii*)	46	38.64
Rib Grass (*Plantaga lanceolata*)	46	38.64
Rough Pigweed (*Amarantus retroflexus*)	37	31.08
Sheep Sorrel (*Rumex acetosella*)	34	28.56
Crab Grass (*Panicum sanguinale*)	34	28.56
Dooryard Plantain (*Plantago major*)	30	25.2
Lamb's Quarter (*Chenopodium album*)	25	21
Bracted Plantain (*Plantago aristata*)	20	16.8
Evening Cockle (*Siline noctiflora*)	18	15.12
Canada Thistle (*Cuicus arvensis*)	14	11.94
Old Witch Grass (*Panicum capillare*)	13	10.98
Barnyard Grass (*Panicum Crus-galli*)	10	8.4
Smooth Crabgrass (*Panicum glabrum*)	8	6.76
Bull Thistle (*Cuicus lanceolatus*)	6	5.16
Wild Carrot (*Daucus carota*)	6	5.16
Blue Vervain (*Verbena hastata*)	4	3.36
Hoary Vervain (*Verbena stricta*)	4	3.36
Spurge (*Euphorbia*)	4	3.36
Peppergrass (*Lepidium apetalum*)	4	3.36
Dodder (*Cuscuta arvensis*)	3	2.58
Pale Smartweed (*Polygonum*)	3	2.58
English Charlock (*Brassica Sinapistrum*)	3	2.58
Small Ragweed (*Ambrosia artemisiaefolia*)	3	2.58
Brome Grass (*Bromus*)	3	2.58
Tumbling Pigweed (*Amarantus retroflexus*)	2	1.68
Rape (*Brassica rapa*)	2	1.68
Field Thistle (*Cnicus*)	2	1.68
Pennsylvania Smartweed	2	1.68
Millet (*Panicum miliaceum*)	2	1.68
Nimblewill (*Muhlenbergia diffusa*)	2	1.68
Black Bindweed (*Polygonum Convolvulus*)	2	1.68
Five Finger (*Potentilla Monspeliensis*)	2	1.68
Cow Herb (*Saponaria Vaccaria*)	2	1.68
Bitter Dock (*Rumex obtusifolius*)	2	1.68
Alfalfa (*Medicago sativa*)	2	1.68
Prairie Clover (*Petalostemon*)	1	.84
Water Smartweed (*Polygonum Hydropiper*)	1	.84
Wild Sunflower (*Helianthus annuus*)	1	.84
Sweet Clover (*Melilotus alba*)	1	.84
Wavyleaved Thistle (*Cuicus undulatus*)	1	.84
Yellow Trefoil (*Medicago lupulina*)	1	.84
Water Hemp (*Acnida tuberculata*)	1	.84
Peach Leaved Dock (*Rumex altissimus*)	1	.84
Willow Leaved Dock (*Rumex salicifolius*)	1	.84
Fowl Meadow Grass (*Poa serotina*)	1	.84
Knot weed (*Polygonump acre*)	1	.84
Knot grass (*Polygonum aviculare*)	1	.84
Slender Knotweed (*Polygonum tenue*)	1	.84
Lettuce, Wild (*Lactuca sativa*)	1	.84
Marsh elder (*Iva axillaris*)	1	.84
Meadow Parsnip (*Pastinaca sativa*)	1	.84
Millet Grass (*Seteria verticillata*)	1	.84
Mesquite Grass (*Bouteloua oligostachya*)	1	.84
Black Mustard (*Brassica nigra*)	1	.84

Orchard Grass (*Dactylis glomerata*)	1	.84
Blue Grass (*Poa pratensis*)	1	.84
Burr-seed (*Fchinospermum Lappula*)	1	.84
Burr-weed (*Iva xanthiifolia*)	1	.84
Bladder-Campion (*Silene cucubalis*)	1	.84
Chicory (*Cichorium Intybus*)	1	.84
Corn Cockle (*Lychnis Githago*)	1	.84
Quack Grass (*Agropyron repens*)	1	.84
Wild Comfrey (*Cynoglossum Virginicum*)	1	.84
Wild Oats (*Avena fatua*)	1	.84
Wild Turnip (*Brassica campestris*)	1	.84
Sand	37	31.08

The following is a list of the weed seeds found in the total of two hundred and fifty-five samples of clover examined. They are listed in the order of their importance. It will be noted that timothy heads the list being found in one hundred and sixty-two out of two hundred and fifty-five samples, this perhaps ought not to be included with true weed seeds.

WEED SEEDS IN 255 SAMPLES RED CLOVER. ORDER OF IMPORTANCE.

Weed Seed	No. Times Found	Percent S'mpl's Cont'ng
Timothy (*Phleum pratense*)	162	64.8
Sand and Dirt	138	55.4
Yellow Foxtail (*Setoria glauca*)	135	54.0
Green Foxtail (*Setaria viridis*)	128	50.2
Rugel's Plantain (*Plantago Rugelli*)	111	44.4
Curled Dock (*Rumex crispus*)	110	44.0
Rib Grass (*Plantago lanceolata*)	108	43.2
Lady's Thumb (*Polygonum persicaria*)	94	37.6
Sheep Sorrel (*Rumex acetosella*)	86	34.4
Crab-grass (*Panicum sanguinale*)	71	28.4
Rough Pigweed (*Amarantus retroflexus*)	64	25.6
Lamb's Quarter (*Chenopodium album*)	47	18.8
Bracted Plantain (*Plantago aristata*)	38	13.6
Old Witch Grass (*Panicum capillare*)	31	12.4
Dooryard Plantain (*Plantago major*)	30	12.0
Canada Thistle (*Cnicus arvensis*)	24	9.2
Barnyard Grass (*Panicum Crus-galli*)	22	8.8
Evening Cockle (*Silene noctiflora*)	22	8.8
Smooth Crab-grass (*Panicum glabrum*)	20	8.0
Bull Thistle (*Cnicus lanceolatus*)	15	6.0
Spurge (*Euphorbia sp.*)	12	4.8
Dodder (*Cuscuta arvensis*)	10	4.0
Wild Carrot (*Daucus carota*)	7	2.8
Starry Campion (*Silene stellata*)	7	2.8
Blue Vervain (*Verbena hastata*)	4	1.6
Hoary Vervain (*Verbena stricta*)	4	1.6
Pepper grass (*Lepidium apetalum*)	4	1.6
English Charlock (*Brassica sinapistrum*)	3	1.2
Small Ragweed (*Ambrosia artemisiaefolia*)	3	1.2
Pale Smartweed (*Polygonum*)	3	1.2
Brome Grass (*Bromus sp.*)	3	1.2
Rape (*Brassica rapa*)	2	.8
Field Thistle (*Cnicus discolor*)	2	.8
Pennsylvania Smartweed (*Polygonum Pennsylvanicum*)	2	.8
Millet (*Panicum miliaceum*)	2	.8
Nimble Will (*Muhlenbergia diffusa*)	2	.8
Black Bindweed (*Polygonum Convolvulus*)	2	.8
Five Finger (*Potentilla Monspeliensis*)	2	.8
Cowherb (*Saponaria Vaccaria*)	2	.8
Alfalfa (*Medicago sativa*)	2	.8
Bitter Dock (*Rumex obtusifolius*)	2	.8
Prairie Clover (*Petalostemon*)	1	.4
Water Smartweed (*Polygonum*)	1	.4
Wild Sunflower (*Helianthus*)	1	.4
Sweet Clover (*Melilotus alba*)	1	.4
Wavy-leaved Thistle (*Cnicus undulatus*)	1	.4

Yellow Trefoil (*Medicago lupulina*)	1	.4
Water Hemp (*Acnida tuberculata*)	1	.4
Peach-leaved Dock (*Rumex altissimus*)	1	.4
Willow-leaved Dock (*Rumex salicifolius*)	1	.4
Fowl Meadow Grass (*Poa serotina*)	1	.4
Knot grass (*Polygonum aviculare*)	1	.4
Knotweed (*Polygonum acre*)	1	.4
Slender Knotweed (*Polygonum tenue*)	1	.4
Lettuce (*Lactuca sativa*)	1	.4
Marsh Elder (*Iva axillaris*)	1	.4
Meadow Parsnip (*Pastinaca sativa*)	1	.4
Millet Grass (*Setaria verticillata*)	1	.4
Mesquite grass (*Bouteloua oligostachya*)	1	.4
Black Mustard (*Brassica nigra*)	1	.4
Orchard Grass (*Dactylis glomerata*)	1	.4
Blue Grass (*Poa pratensis*)	1	.4
Burr seed (*Echinospermum Lappula*)	1	.4
Burr weed (*Iva xanthiifolia*)	1	.4
Bladder Campion (*Silene cucubalus*)	1	.4
Chicory (*Cichorium Intybus*)	1	.4
Corn Cockle (*Lychnis Githago*)	1	.4
Quack Grass (*Agropyron repens*)	1	.4
Wild Comfrey (*Cynoglossum Virginicum*)	1	.4
Wild Oats (*Avena fatua*)	1	.4
Wild Turnip (*Brassica campestris*)	1	.4

A portion of the data presented in the above table is represented graphically in the following diagram. (Fig. 2).

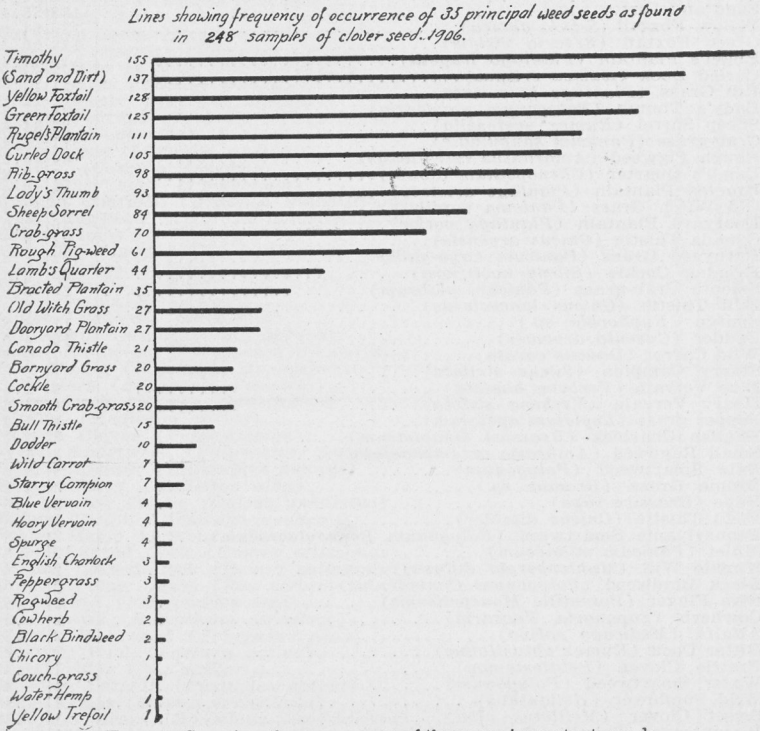
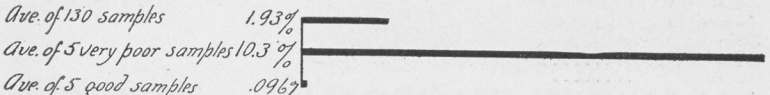


FIG. 2. Showing the occurrence of the more important weeds.

Among the weed seeds found which deserve special emphasis may be mentioned the following: Rib grass or rib plantain found in ninety-eight samples is a seed that is of comparatively recent introduction into Iowa, but the numerous specimens sent to the Station for identification during the last year would indicate that it is very rapidly spreading over the state. The seed is very difficult to remove from clover seed on account of its size and shape. Bracted plantain found in thirty-five samples is very closely related to the preceding plant, and, although at present not as extensive in distribution, the indications are that it may prove as troublesome. Twenty-one samples contained Canada thistle, probably the worst weed that any farmer could introduce upon his land. It is among the most difficult to eradicate of any of our weeds. Dodder found in ten samples is on a plane with the Canada thistle so far as danger to the farmer is concerned. It is only within comparatively recent years that it has been found in the state in clover meadows, but numerous specimens have been sent for identification during the last year. The seed is difficult to separate from that of the clover on account of its size, and the plant when once introduced into a clover meadow strangles to death all of the clover plants within reach. The amount of sand and dirt in most cases was not excessive, but in a few cases there had evidently been added quartz sand. A small amount of this sand by volume materially increases the weight of a bushel of clover seed.

The following diagram will give some conception of the number of weed seeds introduced in a single ounce of impure clover seeds. Frequently some of the weed seeds present in the largest quantities are the least obnoxious, but the presence of even a single seed of the Canada thistle or of dodder should be enough to condemn the seed from the farmer's standpoint. (Fig. 3).



Lines showing comparison of average, poor and good samples of clover seed with respect to impurity content.

The following table is inserted to emphasize the vast difference in the weed seed content of some of the poorer and some of the better samples. The presence in the open market of samples such as are analyzed under the heading of good clover shows that the seedman can put the best quality of seed upon the market if he will. Many of these weed seeds can be removed from the clover by proper cleaning and in many cases the good quality of the seed is undoubtedly due to such cleaning. Some of these,

however, are of such size and shape as to render ineffective any ordinary cleaning.

IMPURITY CONTENT OF FIVE TYPICAL POOR SAMPLES OF CLOVER SEED, CONTRASTED WITH FIVE TYPICAL GOOD SAMPLES OF CLOVER SEED, 1906.

Weed	Sample Number									
	79	115	106	70	89	130	102	26	123	8
Lamb's quarter	.765									
Spurge	2.649									
Old Witch Grass	4.63				.037					
Crab Grass	3.659				.111				.033	
Timothy	2.882	1.207	.69	.208	1.88				.022	
Bracted Plantain	.185		.069							
Canada Thistle		.707								
Bull Thistle		1.04	.069							
Sheep Sorrel		.75	.5	.09	.067				.066	
Curled Dock		2.05	5.	.104	.086					
Yellow Foxtail		3.704		2.228	.522					.2
Green Foxtail		1.25		2.106	.912					
Nightflowering Catchfly			2.1		.043					
Rugel's Plantain			.002		.089					
Lady's Thumb			.69	.104	.063					
Ribgrass				.114	.048					
White Clover					1.002					
Other Weeds	.111	2.02	.236		.021			.093		
Sand and Dirt	4.327		.138	1.136	2.292			.066		
Total	18.606	10.779	8.028	6.906	7.187	0	0	.159	.121	.2
Average					10.301					.096

The following table gives graphically the average impurities of the one hundred and thirty samples examined by weight and in comparison the average of five very poor samples and five unusually good ones. (Fig. 4).

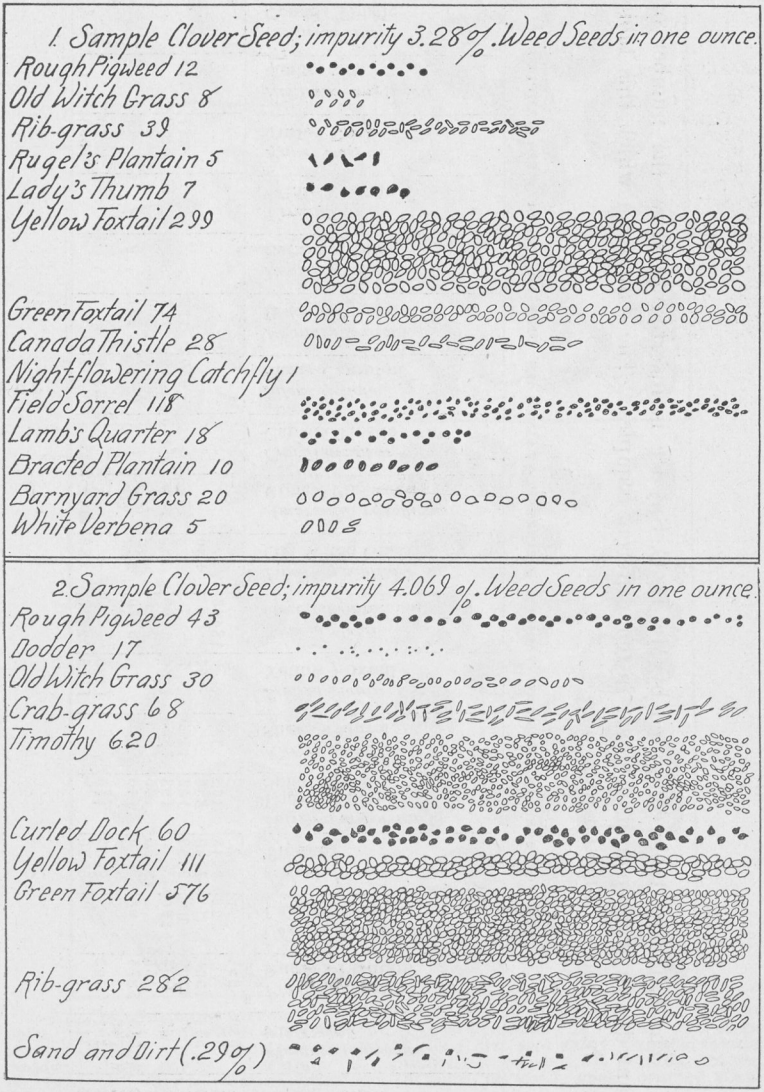


FIG. 4. Impurities found in five different grades of clover seed.

The following table computed by Mr. D. C. Snyder is inserted to show the number of weed seeds planted with every pound of clover in ten different samples. The data from which this table is compiled may be found in table on page 58.

NO. OF FOREIGN SEEDS OF VARIOUS SPECIES CONTAINED IN ONE POUND OF TEN SAMPLES.

No. of Sample	*Plantago lanceolata* Rib Grass	*Plantago Rugelii* Rugel's Plantain	*Chenopodium album* Lamb's Quarter	*Phleum pratense* Timothy	*Polygonum persicaria* Lady's Thumb; Smart Weed	*Rumex acetosella* Sheep's Sorrel	*Setaria glauca* Yellow Foxtail	*Setaria viridis* Green Foxtail	*Panicum capillare* Old Witch Grass	*Amarantus retroflexus* Rough Pig-weed	*Cnicus arvensis* Canada Thistle	*Silene stellata* Starry Campion	*Plantago aristata* Bracted Plantain	*Panicum Crus-galli* Barnyard Grass	*Verbana* White Vervain	*Rumex crispus* Curled Dock	*Panicum sanguinale* Crab-grass	*Cnicus arvensis* Canada Thistle	*Cuscuta arvensis* Field Dodder	*Cnicus lanceolatus* Bull Thistle
1	9980	294						18443												
5			22	3248	165	385			830											
16	554	7960		1155	850		57			353		650	123			287	165			
27		4100	190	9430	142	1775	5						171	320	76					
28	63	85	290		108	1895	4784	1100	165	190	465	16	2200							
37		155		49255	65								151			43	250			
45	2665	5874	98	7990	140	363		8810	635									4	85	85
46	16748							563								1520			314	21
55	3391	193		8160	110		1320					3370				1088			272	
112	4712			9920			1776	9216	480	668										

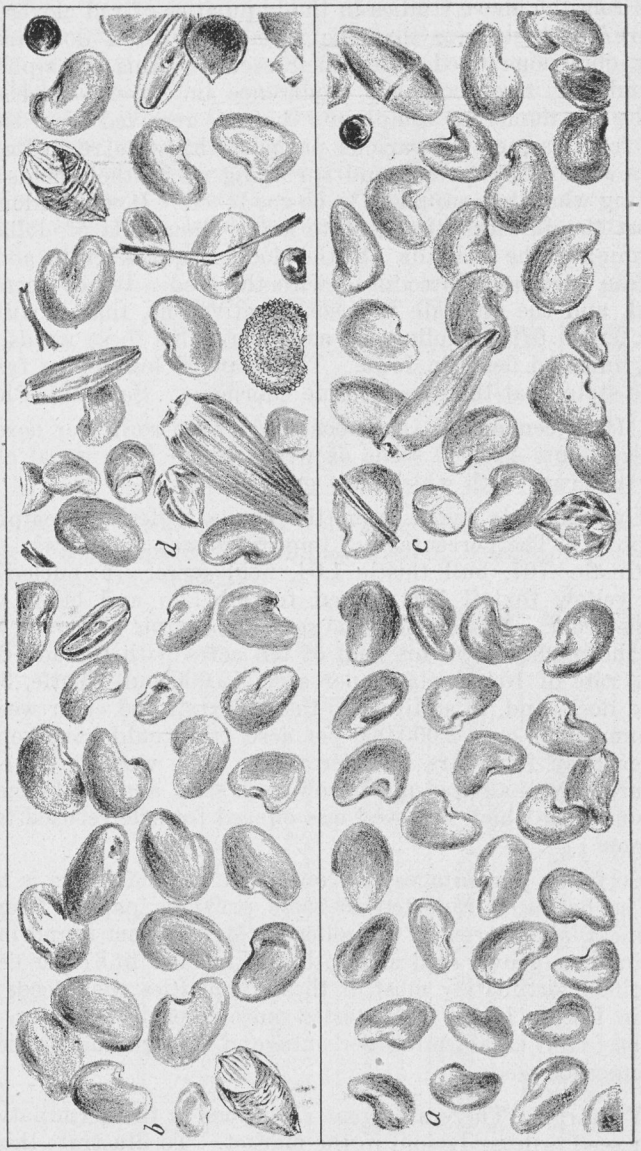


FIG. 9. SHOWING DIFFERING GRADES OF CLOVER WITH IMPURITIES. *a*. Pure seed. *b*. The impurities consisting of pigeon grass and buckhorn and some shrivelled seed. *c*. Impurities consist of some dirt and chaff, Canada thistle, dodder, sheep sorrel, goosefoot. *d*. Impurities consist of Canada thistle, catchfly, bull thistle, foxtail, buckhorn, dodder, pigweed, dock, bracted plantain. This is a poor quality of seed.

From the above studies in the impurities of red clover seeds we are led to believe that the farmers of Iowa do introduce many obnoxious weeds with their seeds. This is emphasized not only by their constant occurrence in clover samples, but also by the numerous complaints that are received from time to time from farmers in various parts of the state regarding the weeds which they have found springing up in their fields after planting what they supposed to be good seed. It will undoubtedly cost the farmers of the state many thousands of dollars to exterminate the Canada thistle, dodder, quack grass and rib plantain carelessly introduced with the seed. It has been estimated, and the estimate is a conservative one, that it will cost from ten to fifteen dollars an acre to remove these weeds from badly infested fields in Iowa. The financial loss to the farmers of the state is at the present time enormous. Says Mr. Pieters:

"If fifteen pounds (of poor seed) were sown per acre, the farmer plants 414,000 seeds of weeds which have equal chance with the crops with which they grow."

One example taken from the above tables will emphasize this point. The percentage of impurities was as follows: Canada thistle .707, bull thistle 1.04, field sorrel .75, curled dock 2.05, yellow foxtail 3.04, green foxtail 1.25 and other weeds 2.02 per cent. The farmer who sent this sample of clover would have thoroughly sown his field of ten acres with Canada thistle at the rate of 10,000 plants per acre, 15,000 bull thistle, 30,000 curled dock, and, in addition to these, foxtail and other weeds to the number of over 2,000,000 per acre. It would have kept the farmer busy for years to exterminate these weeds. Of course the farmer was advised not to sow such seed, and the farmers of the county in which this seed was offered for sale refused to buy the same.

So far as percentages are concerned, the maximum is not as high as has been reported in some previous papers from the Botanical laboratories of the college. Mr. Stewart found impurities in Iowa grown seed amounting to from .3 to 67 per cent at that time, fortunately most of these impurities were seeds common in Iowa. In the seeds tested more recently, however, there is to be found an alarming percentage of foreign and particularly dangerous seeds.

Vitality. There are great variations in the germination of clover seed ordinarily sold in the market. To illustrate this fact and for the sake of comparison we have, besides our own records, detailed the results reached by several other investigators. In addition to the percentage of vitality the actual cost per bushel of good seed in various samples is emphasized.

Taking the following table of some of the results reached in the seed laboratory of the United States Department of Agriculture, we find that the price paid was by no means always proportional to the real value. Sample 7, though of inferior seed and sold most cheaply, was really the most expensive, while for sample 6 less was paid per pound of good seed than for any of the others. Most of these samples were purchased in the same place, and two of them, numbers 1 and 3, from the same dealer. They illustrate how little local dealers regulate prices according to the real value of seed. [1]

TABLE I.—COMPARISON OF MARKET PRICE OF CLOVER SEED WITH PRICE ACTUALLY PAID FOR GOOD SEED.

Sample Number	Market Price Per Bushel (60 Pounds)	Per Cent of Good Seed	No. Pounds Good Seed Per Bushel	Price Paid Per Bushel of Good Seed
1	5.50	93	55.8	5.88
2	5.25	76.2	45.72	6.90
3	5.00	92	55.2	5.40
4	4.75	93	55.8	5.10
5	4.75	80.1	48	5.94
6	4.00	87.3	52.38	4.59
7	3.50	46.2	27.72	7.56

Selby and Hicks give the following table showing the percentage of seed capable of germination and the cost of pure germinable seeds per bushel. [2]

No. of Sample	Market Price Per Bushel	Per Cent Pure Seed	Per Cent Germinated End of 5 Days	Total Per Cent Germinated End of 14 Days	Per Cent Pure Germinable Seed	Cost of Pure Germinable Seed Per Bushel
1	$ 5.00	95.3	71.1	80.6	76.8	$ 6.51
2	5.25	99.4	71.5	75.2	75.0	7.00
3	5.00	98.4	49.1	72.1	70.9	7.05
4	4.50	98.3	71.7	77.4	76.1	5.92
5	.....	99.1	90.3	96.1	95.2	.....
6	5.00	98.4	82.4	87.5	86.1	5.81
7	6.90	99.9	88.5	88.9	88.7	7.78
8	4.50	97.4	83.9	83.9	81.7	5.51
9	.....	96.0	75.3	75.8	72.8	.....
10	5.50	99.5	92.3	93.0	92.5	5.95
11	4.50	98.3	71.4	74.4	73.1	6.16
12	5.00	99.4	91.0	91.6	91.0	5.50
13	1.25	61.1	45.0	52.7	32.1	3.90
14	4.50	99.5	85.7	95.9	95.4	4.72
15	5.00	93.1	90.6	93.2	86.8	5.76
16	7.25	98.7	39.3	65.4	64.5	11.24
17	7.00	98.2	64.5	68.8	67.5	10.37
18	6.75	98.5	64.5	67.5	66.4	10.16
19	7.00	99.6	79.1	92.3	91.9	7.60
20	7.00	99.4	82.4	92.5	91.9	7.60
21	7.00	99.8	64.2	87.4	87.2	8.02
22	6.00	98.6	94.2	96.4	95.	6.31
23	6.00	98.9	89.4	94.8	93.7	6.40
24	10.00	99.7	85.6	94.	93.7	10.67
25	7.25	99.7	88.9	91.1	90.8	7.98
26	6.80	99.8	87.4	88.9	88.7	7.66
27	6.60	99.7	88.1	90.5	89.2	7.39
28	7.80	99.7	87.5	90.9	98.7	7.90

The preceding tables show beyond question that between selling price and real value there is no certain relation.

1 Farmers' Bull., U. S. Dept. Agrl. 111.
2 Ohio Agrl. Expt. Sta. 142:125.

In foreign countries the vitality required of seeds is very high in comparison with our own standards. In Switzerland red clover must have a vitality of 95 per cent. In the Seed Control Act in the Dominion of Canada the vitality required is 90 per cent, or ninety out of ninety-nine seeds. In Schleswig-Holstein the tags, dated and guaranteed on the seeds reported for sale in the province, for one year were as follows: [1]

Kind of Seed	Guarantee			Result of Testing		
	Purity	Germinative Ability	Intrinsic Worth	Purity	Germinative Ability	Intrinsic Worth
	Per cent					
Red clover.....	97.5	90	87.70	97.12	91.50	88.87
Crimson clover....	97.0	98	96.00	96.80	96.00	92.90
White clover.....	98.0	85	83.30	96.60	83.75	80.99

As a result of an eleven years' seed testing by Samek,[2] it was found that after the first year red clover showed a vitality of 90 per cent, white clover 74 per cent and alsike clover 73 per cent. At the end of five years the vitality test showed red clover 74 per cent, white clover 50 per cent and alsike clover 15 per cent, at the end of ten years, red clover 3 per cent, white clover 23 per cent, alsike clover 3 per cent.

It appears from the data collected by Mr. C. L. Parsons, [3] in this country, that the vitality of clover and alfalfa seed sold is rather low. This writer finds that alfalfa has an average vitality of 61.6, alsike clover 72.7, crimson clover 59, red clover 84.8, mammoth clover 82.5, and white clover 72.1 per cent. It is evident from the data collected by Mr. Parsons that the American seedsmen are either selling an inferior lot of clover seed or that the clover seed of this country does not retain its vitality as long as that of Europe.

The vitality of the red clover is given at 85 to 90 per cent in the Year Book of the U. S. Department of Agriculture, and yet by looking at the tables given it will be seen that some samples last spring germinated 100 per cent and others showed a germination of 95 per cent. Moreover, the fact that some of the European seed merchants guarantee a germination of 95 per cent leads us to believe that the standards of vitality can be very materially increased in this country.

The following tables present in concrete form the results of our investigations of the germination of red clover seeds. In a number of cases seeds were germinated in the spring, March, 1906, and other seeds from the same package were germinated

1 Landw. Wochenbl. Schles. Holst. 44:592.
2 Tirol. Landw. Blätter 13:161. Expt. Sta. Record U. S. Dept. of Agrl. 6:429.
3 Agri. Sci. 7:541.

again in the fall. The seeds were all germinated in sand. This comes as near field conditions as one could desire.

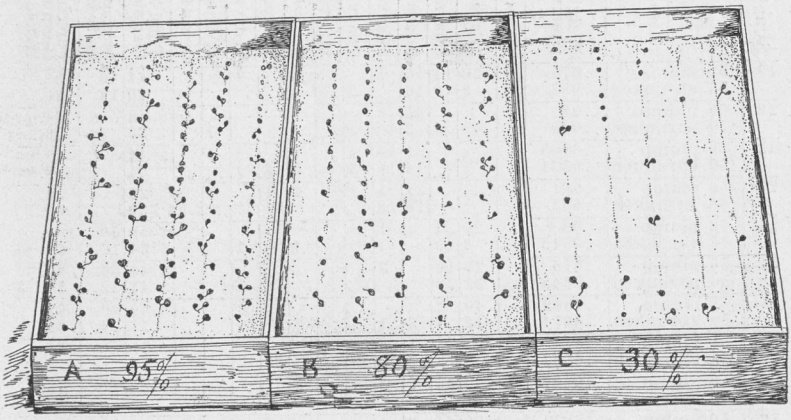


FIG. 6. Drawing showing in comparison the germinating power of three different samples of clover seed, the first having germinated 95 per cent, second 80 per cent, and third 30 per cent. Drawn by Charlotte M. King.

GERMINATION OF RED CLOVER SEED.

Tested March, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination for first 5 days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
2	180 plump	2.2375	64	44	24	6	4		1						143	60.	79.5
	20 shrunken	.0126	2	3					1	2					8	25.	40.
2a	50 plump	.0794		42			1								43	84.	2.86
	50 shrunken	.0446		7	1										8	14.	2.28
5	185 plump	.309		169	1			5		2		3	1		183	91.4	99.9
	15 shrunken	.0232		6									2		8	40.	53.3
8a	50 plump	.0816		31	1										32	60.	64.
	50 shrunken	.0472		18											18	36.	36.
9	50 plump	.0995				6	28		2			1			37		74.
	50 shrunken	.07					16	5	1				2	2	27		54.
9a	50 plump	.0868		41	1										42	82.	84.
	50 shrunken	.0667		30	4										34	60.	68.
10	50 plump	.0878			1					12				10	23	2.	46.
	50 shrunken	.0695				1									1		2.
12	50 plump	.0866		27		4	4								35	54.	70.
	50 shrunken	.05															
14	50 plump	.09			4										4	8.	8.
	50 shrunken	.061															
18	50 plump	.09		15	19	8	2	2		1					37	30.	74.
	50 shrunken	.06			34	3									37		74.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination											Total Number Germinating	Percentage of Germination for first 5 days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
19	50 plump	.075		20	11	16	5			1		1			44	40.	88.
	50 shrunken	.053		9	9	16		2		4					40	18.	80.
20	50 plump	.08				35	5			2					42		84.
	50 shrunken	.049			8	3	10	2		1			1		25		50.
23	50 plump	.0805				21	16	1		4		1	1		44		88.
	50 shrunken	.0531				14	10	3		3	3	1			34		68.
27	50 plump	.081				22	1	1		2	1				27		54.
	50 shrunken	.053				10	18				1			1	30		60.
28	50 plump	.09		25	24		1								50	50.	100.
	50 shrunken	.0545		6	25		1			1		1			34	12.	68.
31	50 plump	.079		28	10		3								41	56.	82.
	50 shrunken	.0645		21	22										43	42.	86.
31a	50 plump	.0869		40	2										42	80.	84.
	50 shrunken	.0671		12	1	3	1								17	24.	34.
35	50 plump	.076			35	1	3								39		78.
	50 shrunken	.0667				4									4		8.
36	50 plump	.0907			36	2	1	1							40		80.
	50 shrunken	.0605				2	2			2					6		12.
36a	50 plump	.0874		39		2	1				1				43	68.	86.
	50 shrunken	.06		28											28	56.	56.
37	50 plump	.0799			32	2		4		1					39		78.
	50 shrunken	.0502					2								2		4.
38	50 plump	.091			37	3	3								40		80.
	50 shrunken	.0617			38		3	2							46		92.
38a	50 plump	.09		33		3		5	1						42	66.	84.
	50 shrunken	.0619		31	1	1		1							34	32.	68.
39	50 plump	.0873			44	4	1			1					50		100.
	50 shrunken	.059				6	9	1		1	1				18		36.
39a	50 plump	.0869		35			2	3	1						41	70.	82.
	50 shrunken	.06		6	3				2	1					12	12.	24.
41	50 plump	.0843		6	31	3	2								42	12.	84.
	50 shrunken	.059			31	2	1	2							36		72.
41a	50 plump	.0727		32	2	4		6	1						45	64.	90.
	50 shrunken	.0591		14	2			3							19	28.	38.
42	50 plump	.08365		10	24	8	1	1		1					45	20.	90.
	50 shrunken	.0586		12	21	4		2		1		1			41	24.	82.
43	50 plump	.0737					1								1		2.
	50 shrunken	.0507				30	1	1		3	1				36		72.
44	50 plump	.0812			50										50		100.
	50 shrunken	.0411			30	3									33		66.
45	50 plump	.0665			25	9	6								40		80.
	50 shrunken	.04			18	4	6			1	1				30		60.
48	50 plump	.0876				39				7	1				46		92.
	50 shrunken	.05616				20	10	4							35		70.
49	50 plump	.0907		38	1	2		2	5		1				49	76.	98.
	50 shrunken	.0459			20	1		1	1						23		46.
50	100 plump	.091			42	42	3	2		1		1			88		88.
	50 shrunken	.0528			1	21		2		4		4			34		68.
50a	50 plump	.089		36		1		3				1			41	72.	82.
	50 shrunken	.0527		20	6										26	40.	52.

Total number of plump seeds planted	2065
Total number of plump seeds germinated	1648
Total number of shrunken seeds planted	1685
Total number of shrunken seeds germinated	822
Percentage of plump seeds germinating	79.8
Percentage of shrunken seeds germinating	30.9

GERMINATION OF RED CLOVER SEED.
Tested November, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination in first 5 days	Percentage of Germination in Whole Period
			4 days	5 days	5 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
2	50 plump			20	8	7	2		2		1				40	40.	80.
	50 shrunken				2	1	2								5		10.
8	50 plump			11	21	8			5		1				46	22.	92.
	50 shrunken			1	3	4	1		1						10	2.	20.
9	50 plump			26	8	1	2		1		1				39	52.	78.
	50 shrunken			1	16	4	1		1	1					24	2.	48.
10	50 plump				2	2	1		7		1	3			16		32.
	50 shrunken				1		1					2			4		8.
26	50 plump			3	14	7									24	6.	48.
	50 shrunken				1	3			2						6		12.
32	50 plump			1	5	4	1				12				12	2.	24.
	50 shrunken			7	2		1								10	14.	20.
32b	50 plump			5	4		2								11	10.	22.
	50 shrunken			4	8	9	1				2				24	8.	48.
35	50 plump			8	5	3					1				17	16.	34.
	50 shrunken					4			1						5		10.
41	50 plump			13	3		2								18	26.	36.
	50 shrunken				3	6	4		5		1	1			20		40.
43	50 plump			11	7	4	1		1		1				25	22.	50.
	50 shrunken			1	6	4			1						12	2.	24.
44	50 plump			1	5	3									9	2.	18.
	50 shrunken			1	6	8	2		4						21	2.	42.
45	50 plump			13	17	4	1					1			36	26.	72.
	50 shrunken			8	5	3			2						18	16.	36.
50	50 plump			5	12	6									23	10.	46.
	50 shrunken					4	1								5		10.
Average percentage of germination in plump seeds																	48 8-13
Average percentage of germination in shrunken seeds																	25 3-13

ALFALFA.
Test made November, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination in first 5 days	Percentage of Germination in Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
1	50 plump			8	1						1				10	16.	20.
	50 shrunken			2	1	1	1								5	4.	10.

GERMINATION OF MAMMOTH CLOVER.
Tested March, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination for first 5 days	Percentage of Germination in Whole Perion
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
15	50 plump	.071		28		5	1	1						1	34	56.	64.
	50 shrunken	.0587		26		5	3								36	52.	74.
26	50 plump	.0868				17	17				3	1		2	40		80.
	50 shrunken	.042				1	25				2	1			29		68.
Average percentage of germination in plump seeds																	72.
Average percentage of germination in shrunken seeds																	71.

GERMINATION OF MEDIUM RED CLOVER.
Tested March, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination in first 5 days	Percentage of Germination in Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
3	173 plump	.2265	91	41	10	1			3		1	1			147	76.	85.
	27 shrunken	.0125	1		5										6	3.	19.
16	50 plump	.071			16	15	8	16		1					50		100.
	50 shrunken	.047			17	9	1								27		54.
32	50 plump	.08			27	18		2							47	54.	94.
	50 shrunken	.064			17	8		6				1			31	34.	62.
32a	50 plump	.0801			31	6	1	1							39	62.	78.
	50 shrunken	.0593			10	9									19	20.	38.

Total number plump seeds planted	323
Total number plump seeds germinating	283
Total number shrunken seeds planted	177
Total number shrunken seeds germinating	83
Percentage of plump seeds germinating	87.61
Percentage of shrunken seeds germinating	46.88

In six cases the number of germinating shrunken seeds equaled or exceeded the number of germinating plump seeds from same sample.

It will be seen from the above tables that the seeds were separated into two lots, the shrivelled seeds and plump seeds. Every sample was weighed and then placed in sand and allowed to germinate. The day of the first and last germination was indicated. It would seem from the above tables that the average percentage of germination is low, about seventy-nine, and also that seed loses much of its vitality between March and November. In a few cases the shrivelled seeds showed a higher germination than the plump seeds. It was very evident in this case that the plump seed was old. It will be noted further that as compared with European standards the percentage of seeds capable of germination is nearly 15 per cent lower than the required standard and as compared with American standards it is about 5 to 10 per cent lower.

That seed with no higher vitality than that shown by many of these samples is a great loss to the farmer is almost a truism. Not only is the price of the seed lost, but also the use of the land for a season and all the labor involved in land preparation and in sowing. A poor stand of clover undoubtedly is often due to the improper preparation of the soil, but no matter how well tilled the ground may be a good stand cannot be had without good seed.

WHITE CLOVER. (*Trifolium repens*).

Although the studies of the white clover seed are not numerous as those of the red clover or alfalfa, yet it has been studied by numerous investigators referred to in another connection.

DESCRIPTION. Seeds of white clover are small, from 1.20 to 1-30 of an inch long, flattened and often concave on one mar-

gin; varying from nearly square to triangular; margins rounded; the radicle slender club-shaped, thickened near the end and about as long as the cotyledons. Surface of seeds is smooth and dull; color, yellow to light or reddish brown or slightly tinged with green.

ADULTERATION. Adulteration, if practiced, is probably limited to mixing old seeds with the new.

IMPURITIES. In a general way the impurities found in white clover are of two types, the weed seed impurities and grit and dirt. Mr. Hillman of Nevada examined fifty-three samples of white clover and reports on impurities as follows:

WEED SEEDS IN 53 SAMPLES WHITE CLOVER SEED FROM VARIOUS PARTS OF THE UNITED STATES.

Weed Seed	Per cent of Samples Containing
Sheep Sorrel (*Rumex acetosella*)	96.2
Lamb's Quarter (*Chenopodium album*)	88.7
Mayweed (*Anthemis Cotula*)	75.4
Plantain (*Plantago major*)	73.6
Plantain (*Plantago Rugelii*)	66.0
Knotweed (*Polygonum aviculare*)	45.3
Catchfly (*Sileene noctiflora*)	43.4
Timothy (*Phleum pratense*)	43.4
Alsike Clover (*Trifolium hybridum*)	39.6
Pepper grass (*Lepidium intermedium*)	37.7
Catnip (*Nepeta Cataria*)	32.1
Rough Pigweed (*Amarantus retroflexus*)	30.2
Pigweed (*Amarantus albus*)	24.5
Buckhorn (*Plantago lanceolata*)	22.6
Catchfly (*Silene spp.*)	22.6
Larger Mouse-ear Chickweed (*Cerastium vulgatum*)	20.8
Red Clover (*Trifolium pratense*)	20.8
Self Heal (*Brunella vulgaris*)	18.8
Sherpherd's Purse (*Bursa pastoris*)	16.9
Crab grass (*Panicum glabrum*)	16.9
Five Finger (*Potentilla Monspeliensis*)	13.2
Chickweed (*Alsine media*)	11.3
Old Witch Grass (*Panicum capillare*)	11.3
Chickweed (*Alsine graminea*)	9.4
Foxtail (*Chamaeraphis verticillata*)	9.4
Green Foxtail (*Chamaeraphis viridis*)	9.4
Evening Primrose (*Oenothera biennis*)	9.4
Forget-Me-Not (*Myosotis arvensis*)	7.5
Curled Dock (*Rumex crispus*)	7.5
Tumbling Mustard (*Sisymbrium officinale*)	7.5
Corn Spurry (*Spergula arvensis*)	7.5
Crab Grass (*Syntherisma sanguinalis*)	5.7
Corn Chamomile (*Anthemis arvensis*)	3.8
Turnip (*Brassica campestris*)	.3.8
Canada Thistle (*Carduus arvensis*)	.3.8
Storksbill (*Erodium cicutarium*)	3.8
Smartweed (*Polygonum Persicaria*)	3.8
Vervain (*Verbena, various species*)	3.8
Yarrow (*Achillea millefolium*)	1.9
Yellow Rocket (*Barbarea vulgaris*)	1.9
False Flax (*Camelina sativa*)	1.9
Canada Blue Grass (*Poa compressa*)	1.9
Sedge (*Carex spp.*)	1.9
Foxtail (*Chamaeraphis glauca*)	1.9
Wormseed Mustard (*Erysimum sp.*)	1.9
Flax (*Linum usitatissimum*)	1.9
Small-flowered Crane's-bill (*Geranium pusillum*)	1.9
Wild Chamomile (*Matricaria inodora*)	1.9
Black Medic (*Medicago lupulina*)	1.9
White Sweet Clover (*Melilotus alba*)	1.9
Horse mint (*Monarda sp.*)	1.9
Wormseed Mustard (*Erysimum cheiranthoides*)	1.9
Grass-leaved Plantain (*Plantago aristata*)	1.9
Blue Vervain (*Verbena hastata*)	1.9

1 Bull. Nevada Agrl. Expt. Sta. 47.

We found the following impurities in white clover seed: Sorrel, Rugel's plantain, bracted plantain, timothy, curled dock, lamb's-quarter, blue grass and cinquefoil. It will be seen that these impurities are from plants that are found growing close to the ground.

The following table shows the percentages found in nine weighed samples and in five unweighed samples.

WEEDS OF WHITE CLOVER IN ORDER OF FREQUENCY OF OCCURRENCE IN 9 SAMPLES.

	No. Times Found	Per cent Samples Contain'g
Sorrel (*Rumex acetosella*)	4	44.4
Rugel's Plantain (*Plantago Rugellii*)	3	33.3
Sand	1	11.1
Bracted Plaintain (*Plantago aristata*)	1	11.1
Timothy (*Phleum pratense*)	1	11.1
Curled Dock (*Rumex crispus*)	1	11.1
Lamb's Quarters (*Chenopodium album*)	1	11.1
Blue Grass (*Poa pratensis*)	1	11.1
Cinquefoil (*Potentilla*)	1	11.1
Red Clover (*Trifolium pratense*)	1	11.1

WEED SEEDS IN 5 UNWEIGHED SAMPLES WHITE CLOVER SEED. IOWA.

	No. Times Found	Per cent Samples Contain'g
Sheep Sorrel (*Rumex acetosella*)	4	80
Rough Pigweed (*Amarantus retroflexus*)	2	40
Sand	2	40
Timothy (*Phleum pratense*)	2	40
Curled Dock (*Rumex crispus*)	1	20
Evening Cockle (*Silene noctiflora*)	1	20
Five Finger (*Potentilla*)	1	20
Old Witch Grass (*Panicum capillare*)	1	20
Rib Grass (*Plantago lanceolata*)	1	20
Rugel's Plantain (*Plantago Rugelii*)	1	20
Lamb's Quarter (*Chenopodium album*)	1	20
Bracted Plantain (*Plantago aristata*)	1	20

The weed seeds in the samples of the white clover may be seen to resemble very closely those that are recorded for alsike clover. Sheep sorrel is perhaps the most characteristic weed introduced with the seed of either white or alsike clover. Rib-grass or rib-plantain and the closely related bracted plantain are also sometimes found, but it should be entirely possible to free the white clover seed from such impurities. The seeds of these last named weeds are much larger than those of the white clover. No Canada thistle or dodder was found in any of the samples of white clover examined, but it will be seen by reference to Prof. Hillman's table that the former was found by him in a small percentage of cases.

ALSIKE CLOVER. (*Trifolium hybridum*).

Alsike clover has been studied somewhat more generally than white clover because it is a more important crop. Studies have been made by Hillman, Jones, Nobbe and other investigators.

DESCRIPTION. Alsike clover seed varies in length from 1-16 to 1-20 of an inch and is much rounder than alfalfa or red clover. The projecting radicle gives the seed the appearance of having a nearly square top. The color is of peculiar yellowish green to greenish, often brown and mottled. Individual seeds are even yellow or brown; but in mass the seeds have a peculiar yellowish green appearance which will at once distinguish it from white or red clover.

ADULTERATION. Alsike clover is not generally adulterated other than by the addition of old and weedy seed to new.

IMPURITIES. Prof. Hillman [1] who studied thirty-six samples of alsike clover publishes the following table of impurities.

WEED SEEDS IN 36 SAMPLES ALSIKE CLOVER FROM VARIOUS PARTS OF THE U. S.

Weed	Per cent
Sheep Sorrel (*Rumex acetosella*)	86.1
Timothy (*Phleum pratense*)	69.4
Curled Dock (*Rumex crispus*)	52.8
Red Clover (*Trifolium pratense*)	44.4
Lamb's-quarters (*Chenopodium album*)	41.7
Chickweed (*Cerastium vulgatum*)	38.9
Plantain (*Plantago Rugelii*)	33.3
Catchfly (*Silene noctiflora*)	33.3
Mayweed (*Anthemis cotula*)	27.8
Pepper grass (*Lepidium intermedium*)	27.8
Pigweed (*Amaranthus albus*)	25.0
Shepherd's Purse (*Bursa pastoris*)	25.0
Canada Thistle (*Cnicus arvensis*)	25.0
White Clover (*Trifolium repens*)	25.0
Canada Blue Grass (*Poa compressa*)	22.2
Plantain (*Plantago major*)	22.2
Rough Pigweed (*Amarantus retroflexus*)	16.7
Corn Chamomile (*Anthemis arvensis*)	16.7
False Flax (*Camelina sativa*)	16.7
Foxtail (*Setaria verticillata*)	16.7
Buckhorn (*Plantago lanceolata*)	11.1
Five Finger (*Potentilla Monspeliensis*)	11.1
Alfalfa (*Medicago sativa*)	8.3
Crimson Clover (*Trifolium incarnatum*)	8.3
Worm-seed (*Erysimum cheiranthoides*)	8.3
Catnip (*Nepeta Cataria*)	8.3
Old Witch Grass (*Panicum capillare*)	8.3
Tumbling Mustard (*Sisymbrium officinale*)	8.3
Yellow Rocket (*Barbarea vulgaris*)	5.5
Sedge (*Carex spp.*)	5.5
Medic (*Medicago lupulina*)	5.5
Chickweed (*Alsine media*)	2.8
Self Heal (*Brunella vulgaris*)	2.8
Ox-eye Daisy (*Chrysanthemum leucanthemum*)	2.8
Spurge (*Euphorbia nutans*)	2.8
Kentucky Blue Grass (*Poa pratensis*)	2.8
Wild Peppergrass (*Lepidium Virginicum*)	2.8
(*Panicum sp.*)	2.8
Knot weed (*Polygonum aviculare*)	2.8
Golden Glow (*Rudbeckia hirta*)	2.8
Catchfly (*Silene sp.*)	2.8

1 Bull. Nevada Agrl. Expt. Sta. 47:21.

The following table indicates the percentages by weight of the weed seeds found by us in thirty-one weighed samples of alsike clover seeds.

PERCENTAGE BY WEIGHT OF WEED SEED IN 31 SAMPLES ALSIKE CLOVER. IOWA.

Number of Sample	Percentage of Impurities	Dodder	Curled Dock	Field Sorrel	Rugel's Plantain	Dooryard Plantain	Bracted Plantain	Rib-grass	Timothy	Lamb's Quarter	Canada Thistle	Pepper-grass	Evening Cockle	Old Witch Grass	Five-finger	Red Clover	Rough Pigweed	Water Hemp	Green Foxtail	Mustard	Fowl Meadow Grass	Smooth Crab-grass	Night-flowering Catchfly	Crab-grass	Sand and Dirt	Other Weed Seeds
1	1.954	.105	.107		.043				1.523									.087							.175	.07
2	.327			.24					.017																	
3	.223			.206																						
4	.241			.065					.176																	
5	.655			.2					.25												.125				.01	
6	3.656			.224	.03	.03			3.365	.0112											.064	.0112			.045	
7	.184			.041					.143													.432			.112	
8	.615								.09																	
9	2.717								2.48																.269	
10	1.5			1.5														.25					.025			
11	1.26			.188					.24		.167			.417												
12	6.18			.69					5.45																	
13	11.92			.62					6.75		.59						.59									
14	5.12			.52					3.83	.17			.043	.043								.056				
15	5.482			2.57					2.5																	
16	2.01																			.41						
17	.214				.005			.028	.13	.042	.014	.011		.023			.049							.085		.014
18	7.68			.395					5.26							.092	.012			.034						.052
19	5.524			.145	.059				4.77										.034	.034						1.33
20	3.918		.043		.017		1.48		.69	.051									.394							
21	1.493		.046		.017		1.48		.127	.051				.01	.004								.005			
22	5.547		.021						4.933							.578									.577	
23	9.616		.001						8.88	.16						2.843									.73	
24	10.45			.16					10.13		3.553			.077	.006									.008		.008
25	3.939								.309		.014		.045	.011										.015		.105
26	.152			.011					.048																	.433
27	1.56								1.01			.017	.0192	.019									.224		43	
28	4.954			.485		.033			2.4	.313															.551	
29	6.666			.452					.672																2.893	
30	.81			.2					.61																	.65
31	.905								.325																	

Average per cent impurities 3.437.

The following table gives the impurities found in nineteen unweighed samples, the number of times found and the percentage of samples containing them.

IMPURITIES IN 19 UNWEIGHED SAMPLES ALSIKE CLOVER SEED. IOWA.

Weed Seeds	No. Times Found	Per cent Samples, Containing
Timothy (*Phleum pratense*)	18	96
Sheep Sorrel (*Rumex acetosella*)	11	56
Evening Cockle (*Silene noctiflora*)	4	22
Dooryard Plantain (*Plantago major*)	3	17
Rough Pigweed (*Amarantus retroflexus*)	3	17
Crab grass (*Panicum sanguinale*)	3	17
Sand	3	17
Water Hemp (*Acnida tuberculata*)	2	11
Green Foxtail (*Setaria viridis*)	2	11
Smooth Crab Grass (*Panicum glabrum*)	2	11
Starry Campion (*Silene stellata*)	1	6
Bracted Plantain (*Plantago aristata*)	1	6
Wormseed Mustard (*Erysimum cheiranthoides*)	1	6
Wild Carrot (*Daucus carota*)	1	6
Shepherd's Purse (*Capsella Bursa pastoris*)	1	6
Canada Thistle (*Cnicus arvensis*)	1	6
Pepper Grass (*Lepidium apetalum*)	1	6
Spurge (*Euphorbia*)	1	6
Corn Cockle (*Lychnis Githago*)	1	6
Quack Grass (*Agropyron repens*)	1	6
Five Finger (*Potentilla Norvegica*)	1	6
Chicory (*Cichorium Intybus*)	1	6
Dandelion (*Taraxecum officinale*)	1	6
Knot weed (*Polygonum aviculare*)	1	6
Bull Thistle (*Cnicus lanceolatus*)	1	6
Fowl Meadow Grass (*Poa serotina*)	1	6

The following table gives the list of weed seeds in order of their abundance as found in the fifty samples examined, the number of times found and the percentage of samples containing them.

WEEDS OF ALSIKE CLOVER, IN ORDER OF FREQUENCY OF OCCURRENCE IN 50 SAMPLES.

Weed Seeds	No. Times Found	Per cent Samples Containing
Timothy (*Phleum pratense*)	46	94
Sheep Sorrel (*Rumex acetosella*)	39	60.4
Sand	23	47.84
Lamb's Quarter (*Chenopodium album*)	7	14.56
Cockle (*Silene noctiflora*)	7	14.56
Canada thistle (*Cnicus arvensis*)	6	12.48
Crab grass (*Panicum sanguinale*)	6	12.48
Rugel's Plantain (*Plantago Rugelii*)	6	12.48
Rough Pigweed (*Amarantus retroflexus*)	6	12.48
Dooryard Plantain (*Plantago major*)	5	10.4
Old Witch Grass (*Panicum capillare*)	5	10.4
Cinquefoil (*Potentilla Norvegica*)	5	10.4
Smooth Crabgrass (*Panicum glabrum*)	5	10.4
Green Foxtail (*Setaria viridis*)	4	8.32
Peppergrass (*Lepidium sp.*)	3	6.24
Water Hemp (*Acnida tuberculata*)	2	4.16
Wild Carrot (*Daucus carota*)	1	
Wormseed Mustard (*Erysimum cheiranthoides*)	1	2.08
Starry Campion (*Silene stellata*)	1	2.08
Chicory (*Cichorium Intybus*)	1	2.08
Corncockle (*Agrostemma Githago*)	1	2.08
Quack grass (*Agropyron repens*)	1	2.08
Dandelion (*Taraxacum officinale*)	1	2.08
Dodder (*Cuscuta arvensis*)	1	2.08
False Flax (*Camelina satira*)	1	2.08
Fowl Meadow Grass (*Alopecurus pratensis*)	1	2.08
Knot Grass [*Polygonum aviculare*)	1	2.08
Bracted Plantain (*Plantago aristata*)	1	2.08
Ribgrass or Buckhorn (*Plantago lanceolata*)	1	2.08
Shepherd's Purse (*Capsella Bursa pastoris*)	1	2.08
Spurge (*Euphorbia*)	1	2.08
Bull Thistle (*Cnicus lanceolatus*)	1	2.08

A comparison of Prof. Hillman's table and the above will show a striking similarity in results. Particularly noticeable is the universal presence of sheep or field sorrel. This is an excellent example of a weed distributed almost entirely through seed. The alsike and sheep sorrel grow well together. The seed of the sorrel is of such size and shape that it is almost impossible to separate them, and the two grow to about the same height in the field. Nevertheless, many samples were entirely free from the weed, and there is no reason why the weed should become more widely spread than at present through poor seed. Canada thistle was likewise found in six samples. This should make every farmer doubly cautious in his inspection of alsike seed. Hillman likewise records it as of frequent occurrence. Dodder was also found once. The other weed seeds found are common, and in most cases not particularly noxious.

VITALITY. The following tables give the results of tests of the vitality of alsike clover seeds tested in March and November, 1906.

GERMINATION OF ALSIKE CLOVER.
Tested March, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total No. Germinating	Percentage of Germination for First Five Days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
4	172 plump	.0925		50	9			5	3	1		5		1	84	28.9	50.5
	28 shrunken	.01325			4			1		1					6	14.3	21.42
6	50 plump	.0367		3	19	21	3	2							48	6	96
	50 shrunken	.03	1	3	6	12	2	2			1				27	8	54
7	50 plump	.085			4	11	8	4		2	3				32		64
	50 shrunken	.029															
25	50 plump	.037				10	7								17		34
	50 shrunken	.019															
30	50 plump	.0328		23	11	1	2			3					50	46	100
	50 shrunken	.022			23	2									25		
33	50 plump	.04815		5	24		2	2			4				37	10	74
	50 shrunken	.0322			15			2			1				17		34
34	50 plump	.0359			35	3	2			3				1	44		88
	50 shrunken	.023			26		2			2					30		60
34a	50 plump	.0355		36	3		1								40	72	80
	50 shrunken	.0248															
40	50 plump	.03325			40		4			2					46		92
	50 shrunken	.02425			1	1	4			2					8		16
40a	50 plump	.03329		32			4								37	64	74
	50 shrunken	.022		17	1	1	1								20	34	40
46	50 plump	.03165			39	1	1			1					42		84
	50 shrunken	.0198			6	2	18								20		52
47	50 plump	.0328			37	4	2	2		1		1			47		94
	50 shrunken	.0219				3	3	1			1				8		16

Total number plump seeds planted..... 722
Total number plump seeds germinating..... 489
Total number shrunken seeds planted..... 578
Total number shrunken seeds germinating..... 167
Percentage of plump seeds germinating..... 66.34
Percentage of shrunken seeds germinating..... 28.92

GERMINATION OF ALSIKE CLOVER SEED.
Tested November, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage Germinating in 5 days	Percentage Germinating in Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
4	50 plump			3	10	1	5		11		4				34	6.	68.
	50 shrunken						2			1					3		6.
14	50 plump			1		1									2	2.	4.
	50 shrunken																
40	50 plump			1	4	2			2		2				11	2.	22.
	50 shrunken			4	4	1	1					1			11	8.	22.
46	50 plump			10	5		1					1			17	20.	34.
	50 shrunken				1					2					3		6.
47	50 plump			7	13	4	2		7			2			26	14.	52.
	50 shrunken			2	6	1						3			10	4.	20.

Average percentage of germination in plump seeds..... 35 3-5
Average percentage of germination in shrunken seeds..... 10 4-5
In one case the number of germinating shrunken seeds exceeded the number of germinating plump seeds from the same sample.

GERMINATION OF ALSIKE CLOVER SEED. (Samples not tested in March). Tested October, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination for first 5 days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
148	50 plump	.040	20	19	1										40	78.	80.
	50 shrunken	.028	7	12	10	1		2							32	38.	64.
142	50 plump	.032	9	18	10	1				2					40	54.	80.
	50 shrunken	.027	11	7	3	2		5							28	36.	56.
149	50 plump	.039	23	9	1			2		1					36	64.	72.
	50 shrunken	.035	4	5	3										12	18.	24.
140	50 plump	.047	22	10	9	5		1				1			50	64.	100.
	50 shrunken	.036	12	10	2	2		3							29	44.	58.
150	50 plump	.035	17	15	3	1				1				1	38	64.	76.
	50 shrunken	.028	2	11	5	7				1					26	23.	52.
153	50 plump	.032	16	15	12	1				1	1				46	62.	92.
	50 shrunken	.029	6	15	7	2		5							35	42.	70.
133	50 plump	.032	31	7	4	2		1							45	76.	90.
	50 shrunken	.030	15	10	3	2									30	50.	60.
160	50 plump	.037	27	9	7	3		2							39	72.	78.
	50 shrunken	.012	6	12	9	3									30	36.	60.
161	50 plump	.038	13	14	5	1		3			1		1		35	54.	70.
	50 shrunken	.029	8	11	4	1									27	38.	54.
172	50 plump	.036	16	12	4										32	56.	64.
	50 shrunken	.026	6	13	1	1									21	38.	42.
178	50 plump	.035	31	7	3	1	1		1		2				45	76.	90.
	50 shrunken	.025	5	5	1		3								15	20.	30.
188	50 plump	.031	11	19	2										31	60.	62.
	50 shrunken	.027	8	8	2	2				3					23	36.	46.
194	50 plump	.034	14	20	4										38	68.	76.
	50 shrunken	.028	13	17	8	2				1					31	60.	62.
196	50 plump	.036	14	17	2	2		3							38	62.	76.
	50 shrunken	.028	9	7	6	4									26	32.	52.
197	50 plump	.038	18	16	4	2									40	68.	80.
	50 shrunken	.024	2	2	5										9	8.	18.
200	50 plump	.033	18	16	6										40	68.	80.
	50 shrunken	.02	2	4	3										9	12.	18.

Total number of plump seeds planted	800
Total number of plump seeds germinating	633
Total number of shrunken seeds planted	800
Total number of shrunken seeds germinating	383
Percentage of plump seeds germinating	79.1
Percentage of shrunken seeds germinating	49.97

GERMINATION OF ALFALFA SEED.

144	50 plump	.177	16	4	5	1		2		1		3			37	50.	74.
	50 shrunken	.144	5	5	5	1		1							17	20.	14.
164	50 plump	.112	29	11	1					2					43	80.	86.
	50 shrunken	.079	12	19	12										43	62.	86.

Average percentage of plump alfalfa seed	80.
Average percentage of shrunken alfalfa seed	50.

In comparison with the National standard of 75 to 80 per cent vitality it will be seen that there is a variation from 34 to 100 per cent, most of the samples meeting this requirement. It may be again emphasized that undoubtedly our standard could be raised to advantage. A comparison of the planting of samples in the spring and the next fall shows that in the few sam-

ples tested loss of vitality was variable, although on the whole there was some reduction evident.

ALFALFA. (*Medicago sativa*).

Numerous studies have been carried on in connection with alfalfa, both in Europe and in this country. We desire especially to call attention to the work carried on by Profs. Hillman and Roberts.

DESCRIPTION. The seeds of alfalfa are longer than broad, the length varies from 1-9 to 1-12 of an inch. The width is more uniform than that of the red clover; the radicle is less prominent and occasionally at the narrower end of the seed. In some cases the seeds are somewhat spirally coiled. The hilum or scar is quite prominent and is frequently marked by an area of lighter color. The plumule is comparatively small and lies between the two cotyledons. The seeds are rather uniform in color, from light to dark brown or rarely a yellowish green.

ADULTERATION. Alfalfa is frequently adulterated and the chief adulterant is yellow trefoil and occasionally burr clover and sweet clover. It is quite difficult to distinguish the seeds of the above named plants from the alfalfa seeds. Prof. Roberts and Mr. Freeman [1] say:

> "The objection to yellow trefoil and burr clover as adulterants is due not so much to the inferior quality of the forage produced by these plants as to the fact that they are annual plants, whereas alfalfa is perennial, and the expense of reseeding need not be undergone short of 15 to 20 years or more, where a good stand has once been secured. Sweet clover is objectionable as an adulterant for the reason that it is only a biennial and is generally distasteful to stock. The chief impurity in alfalfa seed upon the western market is dead seed of alfalfa itself, the amount of inert matter or debris being relatively less than in average commercial lots of grass seed."

IMPURITIES. Alfalfa contains the seeds of a great many injurious weeds. During the last few years we have received several communications from correspondents in different parts of the state, who reported on the appearance of knap weed, (*Centaurea salsolstitialis*) which is a common and troublesome weed on the Pacific coast. It is also a native of Southern Europe where it is regarded as a very troublesome weed. We have also received letters concerning the appearance of hop clover, black medic (*Medicago lupulina*) and the occasional appearance of burr clover (*Medicago denticulata*) and the presence of two kinds of sweet clover (*Melilotus alba* and *M. officinalis*) and alfalfa dodder. Rib plantain or buck horn and bracted plantain are also reported where alfalfa has been cultivated, indeed, these weed seeds are commonly reported in various states where an

1 Bull. Kans. Exp. Sta. 133:77.

investigation has been made of the impurities found in alfalfa seed.

The impurities in alfalfa seed in Nevada as reported by Prof. Hillman, and in Ohio by Profs. Selby and Hicks are compared with the results reached in our own investigations in the following table:

COMPARISON OF WEED SEEDS OF ALFALFA—IOWA, OHIO AND NEVADA RESULTS.

	Iowa 24 Samples Containing Per cent	Ohio 15 Samples Containing Per cent	Nevada 54 Samples Containing Per cent
Ribgrass (*Plantago lanceolata*)	62.5		13.
Yellow Foxtail (*Chamaeraphis glauca*)	33.3	13.3	3.6
Sand and Dirt	29.1		
Green Foxtail (*Chamaeraphis viridis*)	16.6	33.3	14.8
Wild Carrot (*Daucus Carota*)	12.5		1.8
Barnyard Grass (*Panicum Crus-galli*)	12.5	13.3	5.5
Cockle (*Silene noctiflora*)	12.5		
Bull Thistle (*Cnicus lanceolatus*)	12.5		1.8
Catchfly (*Silene spp.*)			3.6
Canada Thistle (*Cnicus arvensis*)	8.3		
Crab-grass (*Panicum sanguinale*)	8.3		
Smooth Crab-grass (*Panicum glabrum*)	8.3		
Meadow Parsnip (*Pastinaca sativa*)	8.3		
Lamb's Quarters (*Chenopodium album*)	8.3	53.3	35.2
Curled Dock (*Rumex crispus*)	8.3		11.1
Rough Pigweed (*Amarantus retroflexus*)	8.3		20.4
Timothy (*Phleum pratense*)	8.3		14.8
Chicory (*Cichorium Intybus*)	4.1		1.8
Dodder (*Cuscuta Epithymum and arvensis*)	4.1	20.	51.8
Dropseed (*Muhlenbergia Mexicana*)	4.1		18.5
Knotweed (*Polygonum aviculare*)	4.1		22.2
Mayweed (*Anthemis Cotula*)	4.1		3.6
Millet (*Panicum miliaceum*)	4.1	6.6	
Nimble Will (*Muhlenbergia diffusa*)	4.1		
Peppergrass (*Lepidium apetalum*)	4.1		
Field Thistle (*Cnicus discolor*)	4.1		
Sunflower (*Helianthus annuus*)	4.1		9.3
Sorrel (*Rumex Acetosella*)	4.1	6.6	3.6
Flowering Spurge (*Euphorbia*)	4.1		
Rape (*Brassica rapa*)	4.1		
Rugel's Plantain (*Plantago Rugelii*)	4.1		5.5
Bracted Plantain (*Plantago aristata*)	4.1		1.8
Prostrate Pigweed (*Amarantus blitoides*)	4.1	6.6	26.0
Orache (*Atriplex truncata*)		13.3	27.7
Tumbleweed (*Amatantus albus*)			18.5
Cowherb (*Saponaria vaccaria*)			24.0
Grindelia (*Grindelia squarrosa*)			11.1
Marsh-elder (*Iva axillaris*)			11.1
White Sweet Clover (*Melilotus alba*)			11.1
Tall & Bulbous Buttercup (*Ranunculus acris & bulbosus*			11.1
Smaller Ragweed (*Ambrosia artemisiaefolia*)			9.3
Turnip (*Brassica campestris*)			7.4
Pigweed (*Chenopodium murale*)			7.4
Foxtail (*Chamaeraphis verticillata*)			7.4
Lady's Thumb (*Polygonum Persicaria*)			7.4
Black Mustard (*Brassica nigra*)		6.6	5.5
Star Thistle (*Centaurea spp.*)			55.
Storksbill (*Erodium cicutarium*)			5.5
Burr Weed (*Iva xanthiifolia*)		6.6	5.5
Witch Grass (*Panicum capillare*)		20.	5.5
Red Clover (*Trifolium pratense*)			5.5
White Clover (*Trifolium repens*)			5.5
Alsike Clover (*Trifolium hybridum*)			5.5
Selfheal (*Brunella vulgaris*)			3.6
False Flax (*Camelina sativa*)			3.6
Sedges (*Carex spp.*)			3.6
Dwarf Mallow (*Malva rotundifolia*)		13.3	3.6
Common Hoarhound (*Marrubium vulgare*)			3.6

	Iowa 24 Samples Containing Per cent	Ohio 15 Samples Containing Per cent	Nevada 54 Samples Containing Per cent
Evening Primrose (*Oenothera biennis*)			3.6
Black Bindweed (*Polygonum convolvulus*)			3.6
Russian Thistle (*Salsola Tragus*)		6.6	3.6
Bulrush (*Scirpus spp.*)			3.6
Oxtongue Picris (*Pieris echioides*)			3.6
Amsinckia (*Amsinckia tessellata*)			1.8
Chess (*Bromus secalinus*)			1.8
Treacle Mustard (*Conringia orientalis*)			1.8
Stickseed (*Echinospermum Redowskii*)			1.8
Candy Grass (*Eragrostis major*)			1.8
Large Spotted Spurge (*Euphorbia nutans*)			1.8
Wild Lettuce (*Lactuca Scariola*)			1.8
Smartweed (*Polygonum Hydropiper*)			1.8
Five Finger (*Potentilla Monspeliensis*)			1.8
Tansy Mustard (*Sisymbrium canescens*)			1.8
Crab Grass (*Syntherisma sanguinalis*)			1.8
Tumble Weed (*Amarantus graecicans*)		13.3	
Bitter Dock (*Rumex obtusifolius*)		6.6	
Reed Canary Grass (*Phalaris arundinacea*)		6.6	
Fescue Grass (*Festuca ovina*)		6.6	
Wild Mustard (*Brassica arvensis*)		6.6	
Black Bindweed (*Polygonum convolvulus*)		6.6	

The following table gives the percentage weights of impurities determined in ten samples of alfalfa in Iowa.

IMPURITIES IN 10 SAMPLES ALFALFA—IOWA.

Number of Sample	Total Percentage of Impurities	Rough Pigweed (*Amaranthus retroflexus*)	Lamb's Quarter (*Chenopodium album*)	Canada Thistle (*Cnicus arvensis*)	Bull Thistle (*Cnicus lanceolatus*)	Dodder (*Cuscuta arvensis*)	Red Clover (*Trifolium pratense*)	Barnyard Grass (*Panicum Crus-galli*)	Smooth Crab Grass (*Panicum glabrum*)	Crab Grass (*Panicum sanguinale*)	Timothy (*Phlehm pratense*)	Bracted Plantain (*Plantago arvstata*)	Rib Grass *Plantago lanceolata*)	Curled Dock (*Rumex crispus*)	Yellow Foxtail (*Setaria glauca*)	Green Foxtail (*Setaria viridis*)	Other Weed Seeds	Sand and Dirt
1																		
2	1.511	.075					.21		.016			.24	.72	.02	.2		.03	
3	.029														.029			
4	.89		.1					.7		.09								
5	1.345			.183	.697								.62				1.023	
6	.811						.268						.445		.009		.089	
7	2.417												1.59				.827	
8	.577	.013				.011			.013				.17		.149	.145		.075
9	.123												.042					.083
10	.684										.108		.421				.047	.108

Average .838 per cent.

The following table gives the impurities as determined in ten unweighed samples.

TABLE OF IMPURITIES IN 10 SAMPLES ALFALFA.

Name of Weed	No. Times Found	Per cent Samples Containing	Name of Weed	No. Times Found	Per cent Samples Containing
Rib Grass (*Plantago lanceolata*)	8	80	Chicory (*Cichorium Intybus*)	1	10
Yellow Foxtail (*Setaria glauca*)	4	40	Drop Seed (*Muhlenbergia Mexicana*)	1	10
Sand	4	40	Knotweed (*Polygonum aviculare*)	1	10
Green Foxtail (*Setaria viridis*)	3	30	Mayweed (*Anthemis Cotula*)	1	10
Wild Carrot (*Daucus carota*)	3	30	Millet (*Panicum miliaceum*)	1	10
Evening Cockle (*Silene noctiflora*)	3	30	Nimblewill (*Muhlenbergia diffusa*)	1	10
Bull Thistle (*Cnicus lanceolatus*)	2	20	Pepper-grass (*Lepidium sp.*)	1	10
Barnyard Grass (*Panicum Crus-galli*)	2	20	Field Thistle (*Cnicus discolor*)	1	10
Meadow Parsnip (*Pastinaca*)	2	20	Sunflower (*Helianthus*)	1	10
Lamb's Quarter (*Chenopodium album*)	1	10	Sheep Sorrel (*Rumex acetosella*)	1	10
Canada Thistle (*Cnicus arvensis*)	1	10	Flowering Spurge (*Euphorbia*)	1	10
Crab Grass (*Panicum sanguinale*)	1	10	Rape (*Brassica rapa*)	1	10
Timothy (*Phleum pratense*)	1	10	Rugel's Plantain (*Plantago Rugelii*)	1	10
Curled Dock (*Rumex crispus*)	1	10	Prostrate Pigweed (*Amarantus*)	1	10

An examination of the first of these tables proves unusually instructive. It will be noted that in the seed examined at this Station about two-thirds of the samples contained rib-grass or rib plantain, the weed perhaps most common in the alfalfa fields of the Middle West. The Nevada samples examined by Prof. Hillman contained only thirteen per cent, while those examined in Ohio were free from this weed. The numerous complaints which have been received from various localities in the state and the number of specimens of this plant submitted for identification as new weeds confirms that it has been introduced into this state almost entirely through alfalfa. Canada thistle was likewise found in a small percentage of the samples; this was found in still smaller percentages in Nevada and was not reported from Ohio. Canada thistle does not seem to be a weed found very extensively in these localities where alfalfa seeds are grown commercially. It is by no means as common as in the red clover. Dodder was found in one sample only, and no species infesting alfalfa fields have been received by the Botanical Section of the Experiment Station. It is probably true that the alfalfa seed sold in Iowa is grown in a different locality than that examined by Prof. Hillman, as his figures show more than half the samples to be infested. The seeds of the above weeds are particularly difficult to remove from alfalfa seed owing to their shape and size, the only safe course to pursue is rigid examination of all seed sown. If alfalfa is to become a crop generally grown in Iowa, it is to be hoped that the greatest care will be used in selection and examination and that it will not result in the introduction of noxious weeds that will in any measure counterbalance the benefits to be derived from the growing of this new forage crop.

Vitality. The following table gives the results of germination tests on eight samples of alfalfa.

GERMINATION OF ALFALFA SEED. (Tested March, 1906).

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total Number Germinating	Percentage of Germination for first 5 days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
1	179 plump	.353	78	7	2					1	1	3	1		93	48.	49.
	29 shrunken	.03	2	2											4	13.9	13.9
6a	87 plump	.126				3		8			3				14		
	60 shrunken	.09				7	1	2							10		16.
13	50 plump	.1185			6	26	3	1							36		72.
	50 shrunken	.0825				23		5							28		52.
13a	50 plump	.1169		14											14	28.	28.
	50 shrunken	.10802		4		1									5	8.	10.
17	50 plump	.105		21	9	10				1					41	42.	82.
	50 shrunken	.074		5		5	2			1				1	14	10.	28.
17a	50 plump	.1047		26	1	1		1	1			1			31	52.	62.
	50 shrunken	.0739		3						1					4	6.	8.
24	50 plump	.1125				32	2			2			1		37		74.
	50 shrunken	.0965				23	5			1					29		58.
29	50 plump	.097		41	2						2				45	82.	90.
	50 shrunken	.0595															

Total number of plump seeds planted	564
Total number of plump seeds germinating	321
Total number of shrunken seeds planted	389
Total number of shrunken seeds germinating	94
Percentage of plump seeds germinating	56.91
Percentage of shrunken seeds germinating	24.16

Although the number of samples tested was too small to allow very general conclusions, yet in but one case was the vitality as high as that indicated in the government seed standards, namely, from 85 to 90 per cent. The average germination was only 57 per cent, in other words, in these samples tested at least the farmer was paying half of the total cost of his alfalfa seed for seed that will not germinate. Undoubtedly some of the failures to establish alfalfa in various localities in the state have been due not so much to lack of inoculation of the soil with the proper bacteria as to the use of seed very weak in vitality.

TIMOTHY. (*Phleum Pratense*).

Timothy seed is usually much freer of weed seeds and generally has a higher percentage of vitality than clover or blue grass seed. This is perhaps because timothy seed is generally grown on comparatively new meadows and the seed crop is more certain.

DESCRIPTION. Timothy seed is light gray in color, from 1-16 to 1-12 of an inch long, usually with the flowering glume and palet attached to the seed. The flowering glume or larger scale is marked by several more or less prominent nerves or

veins; it is truncate at the top; the shorter scale or palet is also prominent. Many of the seeds are hulled in the process of cleaning, these seeds are more or less transparent. At the lower end of the hulled seed is a darker elongated area, the embroy. Timothy seed hulled or unhulled is easily recognized.

Impurities. Mr. Parsons gives the percentage of impurities in sixteen samples of American grown seed as 7.25. The principal impurities found in timothy seed consists of pepper grass, dog fennel, black-eyed Susan, green foxtail, sour dock, field sorrel, rough cinquefoil, buckhorn, narrow-leaved plantain, ribgrass, common plantain, red top and blue grass. The most common impurities found in seed offered for sale in Iowa will be found in the following table.

The following table gives the record of the percentages by weight of the impurities in six samples of timothy examined at the Iowa Station.

IMPURITIES IN 6 SAMPLES TIMOTHY. IOWA. PERCENTAGES BY WEIGHT.

No. of Sample	Total Per cent of Impurities	Red Clover (*Trifolium pratense*)	Crab-grass (*Panicum sanguinale*)	Buckhorn (*Plantago lanceolata*)	Rugel's Plantain (*Plantago Rugelii*)	Curled Dock (*Rumex crispus*)	Alsike Clover (*Trifolium hybridum*)	Other Weed Seeds	Sand and Dirt
1	16.99	4.					12.0		.99
2	1.47			.2	.05	.1		.4	.7
3	1.65	1.6							.05
4	.073		.063						.009
5	16.0	4.0					12.0		
6	6.97	.28			.146				

Average percentage 7.356. Excluding clovers 1.525.

In the following table will be found a list of the impurities with the number of times found, from twenty-four samples of timothy.

IMPURITIES OF 24 SAMPLES TIMOTHY. IOWA.

Weed Seed, etc.	No. Times Found	Percent of Samples Containing	Weed Seed, etc.	No. Times Found	Per cent of Samples Containing
Sand	16	66 2-3	Pepper Grass (*Lepidium*)	2	8
Red Clover (*Trifolium pratense*)	11	46	Dooryard Plantain (*Plantago major*)	2	8
Crab Grass (*Panicum sanguinale*)	1	4	Pale Persicaria (*Polygonum*)	2	8
Rugel's Plantain (*Plantago Rugelii*)	3	13	Wild Carrot (*Daucus carota*)	1	4
Lady's Thumb (*Polygonum Persicaria*)	5	21	Bottle Brush Grass (*Asprella hystrix*)	1	4
Rough Pigweed (*Amarantus retroflexus*)	4	17	English Charlock	1	4
Green Foxtail (*Setaria viridis*)	4	17	Knotweed (*Polygonum aviculare*)	1	4
Lamb's Quarter (*Chenopodium album*)	4	17	Old Witch Grass (*Panicum capillare*)	1	4
Cinquefoil (*Potentilla Norvegica*)	3	13	Hoary Vervain (*Verbena stricta*)	1	4
Yellow Foxtail (*Setaria glauca*)	3	13	Spurge (*Euphorbia*)	1	4
Pennsylvania Smartweed (*Polygonum Pennsylvanicum*)	2	8	Sedge (*Carex spp.*)	1	4
			Bracted Plantain (*Plantago aristata*)	1	4

As will be seen from the above table none of the weed seeds introduced with timothy are other than those which are common upon the average Iowa farm, furthermore, timothy is comparatively easy to clean and the majority of the samples examined were of first class quality.

WEEDS OF TIMOTHY IN ORDER OF FREQUENCY OF OCCURRENCE IN 30 SAMPLES.

Weeds, etc.	No. Times Found	Percent of Samples Containing	Weeds, etc.	No. Times Found	Percent of Samples Containing
Sand	20	66	Dooryard Plantain (*Plantago major*)	2	6.6
Red Clover (*Phleum pratense*)	15	50	Pale Perscaria	2	6.6
Rugel's Plantain (*Plantago Rugelii*)	5	16	Wild Carrot (*Daucus carota*)	1	3.3
Lady's Thumb (*Polygonum persicaria*)	5	16	Alsike (*Trifolium hybridum*)	2	6.6
Rough Pigweed (*Amarantus retroflexus*)	4	13	Bottle-brush Grass (*Asprella hystrix*)	1	3.3
Green Foxtail (*Setaria viridis*)	4	13	English Charlock (*Brassica Sinapistrum*)	1	3.3
Lamb's Quarters (*Chempodium album*)	4	13	Knotweed (*Polygonum aviculare*)	1	3.3
Clenque-foil (*Potentilla Norvegica*)	3	10	Old Witch Grass (*Panicum capillare*)	1	3.3
Yellow Foxtail (*Setaria glauca*)	3	10	Hoary Vervain (*Verbena stricta*)	1	3.3
Crab Grass (*Panicum sanguinale*)	2	6.6	Spurge (*Euphorbia sp.*)	1	3.3
Pennsylvania Smartweed (*Polygonum Pennsylvanicum*)	2	6.6	Sedge (*Carex spp.*)	1	3.3
Peppergrass (*Lepidium spp.*)	2	6.6	Rib Grass (*Plantago lanceolata*)	1	3.3
			Bracted Plantain (*Plantago aristata*)	1	3.3
			Curled Dock (*Rumex crispus*)	1	3.3

VITALITY. The good timothy seed should have a vitality of 85 to 90 per cent. Mr. Parsons records the average of American seed tests to be 80.1 per cent. The following table indicates the condition of the timothy seed.

GERMINATION OF TIMOTHY SEED.
Tested October, 1906.

Sample Number	Seeds Tested	Weight in Grams	Period Required for Germination												Total No. Germinating	Percentage of Germination for First Five days	Percentage of Germination for Whole Period
			4 days	5 days	6 days	7 days	8 days	9 days	10 days	11 days	12 days	13 days	14 days	Over 14 days			
146	50 plump	.019				6		1		2					9		18
	50 shrunken	.019				1		6							7		14
152	50 plump	.020				8		17		1					26		52
	50 shrunken	.018				3		9		1			1		14		28
167	50 plump	.016				21		14					4	1	40		80
	50 shrunken	.016				3		36		1					40		80
179	50 plump	.021				31		6		1	1				39		78
	50 shrunken	.02				28		10		4	1				43		86
182	50 plump	.026				44		4		1					49		98
	50 shrunken	.022				26		13		4					43		96
189	50 plump	.02			11	15		4		2					32		64
	50 shrunken	.02			6	27		1							34		68
191	50 plump	.02			9	24		1							34		68
	50 shrunken	.016			9	24			1						34		68
193	50 plump	.021			14	12	1								27		54
	50 shrunken	.02			8	6		11					1		26		52

Total number plump seeds planted	400
Total number plump seeds germinating	256
Total number shrunken seeds planted	400
Total number shrunken seeds germinating	231
Percentage of plump seeds germinating	64
Percentage of shrunken seeds germinating	27.7

Only eight samples of timothy seed were tested as to germinative energy and, hence, no very general conclusions can be drawn. The average percentage of germination is only sixty-four.

GENERAL DISCUSSION OF IMPURITIES FOUND IN AGRICULTURAL SEEDS.

The following table has been compiled to show the number of seeds of various species of weeds to be found in one gram. To convert this table into one reading, multiply the number of seeds per pound by 453.584.

NUMBER OF SEEDS TO THE GRAM IN WEED SEEDS FOUND AS IMPURITIES IN CLOVER SEED. PREPARED BY D. C. SNYDER.

Abutilon Avicennae (Velvet leaf)	109
Acnida tuberculata (Water Hemp)	2800
Amarantus retroflexus (Tumbleweed)	2684
Arctium Lappa (Burdock)	320
Brassica nigra (Black Mustard)	1280
Bassica sinapistrum (Hedge Mustard)	496

Camelina sativa (False Flax)	900
Cassia Chamaecrista (Partridge Pea)	119
Chenopodium album (Pigweed)	1440
Cnicus arvensis (Canada Thistle)	880
Cnicus discolor (Thistle)	174
Cnicus lanceolatus (Bull Thistle)	620
Cnicus lanceolatus (dup)	456
Cuscuta arvensis (Dodder)	1688
Cuscuta Trifolii (Clover Dodder)	3840
Cyperus esculentus (Nut grass)	540
Datura Stramonium (Jimson weed)	146
Euphorbia Preslii (Spurge)	1720
Hibiscus trionum (Mallow)	304
Ipomea purpurea (Morning glory)	41
Lepidium apetalum (Peppergrass)	2515
Melilotus alba (Sweet clover)	490
Medicago sativa (Alfalfa)	452
Medicago lupulina (Trefoil)	692
Monarda fistulosa (Horsemint)	1080
Nepeta Cataria (Catnip)	1076
Oxybaphus nyctaginea (Oxybaphus)	404
Panicum capillare (Old Witch grass)	2592
Panicum crusgalli (Barnyard grass)	1400
Panicum sanguinale (Crab grass)	3640
Phleum pratense (Timothy)	2888
Plantago aristata (Bracted Plantain)	760
Plantago lanceolata (Rib-grass)	1152
Plantago Rugelii (immature)	2176
Plantago Rugelii (Rugel's plantain)	1704
Poa pratensis (Blue grass)	17050
Poa serotina (False Red top)	10370
Polygonum incarnatum (Smartweed)	640
Polygonum Persicaria (Lady's Thumb)	712
Polygonum convolvulus (Bindweed)	216
Polygonum Pennsylvanicum (Smartweed)	200
Potentilla Norvegica (Five finger)	11880
Rumex acetosella (Sheep sorrel)	2000
Rumex crispus (Curly Dock)	728
Rumex obtusifolius (Dock)	846
Saponaria Vaccaria (Cowherb)	228
Scrophularia nodosa (Simpson weed)	6690
Setaria glauca (Pigeon grass, average size)	815
Setaria glauca (large)	386
Setaria Italica (Millet)	544
Setaria viridis (immature)	2928
Setaria viridis (Green Foxtail)	2140
Silene stellata (Catchfly)	900
Thalictrum purpurascens (Meadow-rue)	496
Trifolium hybridum (Alsike clover)	1604
Trifolium pratense (Red Clover)	662
Trifolium repens (White clover)	1904
Verbena stricta (Vervain)	1028
Verbena urticaefolia (Vervain)	2408
Verbena urticaefolia (Small seed)	1030

The following table is an alphabetical list of all the impurities found in our examinations of weeds, giving in each case the number of samples in which such seed was found and the percentage of the total number of samples which contained them, together with the total number of times which the seed was found.

	Red Clover	Alsike Clover	White Clover	Timothy	Alfalfa	Percentage of 364 Select'd Samples Examined	No. of times weed occurred in 364 samples
Alfalfa (*Medicago sativa*)	2					.54	2
Alsike (*Trifolium hybridum*)				1		.27	1
Barnyard Grass (*Panicum Crus-galli*)	22				3	6.75	25
Bindweed, Black (*Polygonum convolvulus*)	2					.54	2
Bluegrass (*Poa pratensis*)	1		1			.54	2
Bottle-brush Grass (*Gymnostichum hystrix*)				1		.27	1
Brome Grass (*Bromus sp.*)	3					.81	3
Burr-seed, Stick-seed (*Echinospermum Lappula*)	1					.27	1
Campion, Bladder (*Silene cucubalis*)	1					.27	1
Burr-weed, Marsh-elder (*Iva santhiifolia*)	1					.27	1
Campion, Starry (*Silene stellata*)	7	1				2.16	8
Canada Thistle (*Cnicus arvensis*)	24	6			2	8.64	32
Catchfly, Night-blooming (*Lychuis vespertina*)	2	1				.81	3
Charlock, English (*Brassica sinapistrum*)	3			1		1.08	4
Chicory (*Cichorium Intybus*)	1				1	.54	2
Chickweed, Mouse-ear (*Cerastium arvense*)		1				.27	1
Cinquefoil, Five-finger (*Potentilla Norvegica*)	2	5	1	3		2.97	11
Clover, Red (*Trifolium repens*)				15		4.05	15
Cockle, Evening (*Silene noctiflora*)	22	7	1		3	8.91	33
Corn Cockle (*Lychnis Agrostemmna*)	1					.27	1
Couch-grass (*Agropyrum occidentale*)	1					.27	1
Cow-herb, Cockle (*Saponaria vaccaria*)	2					.54	2
Crab-grass (*Panicum sanguinale*)	71	6		2	2	21.87	81
Crab-grass, Smooth (*Panicum glabrun*)	20	5			2	7.29	27
Dandelion (*Taraxacum officinale*)		1				.27	1
Dodder, Field (*Cuscuta arvensis*)	10	1			1	3.24	12
Dock, Bitter (*Rumex obtusifolius*)	2					5.40	2
Dock, Curled (*Rumex crispus*)	110	9	1	2	2	33.48	124
Dock, Peachleaved (*Rumex altissimus*)	1					.27	1
Dock, Willow-leaved (*Rumex salicifolius*)	1					.27	1
Drop-seed Grass (*Muhlenbergia diffusa*)					1	.27	1
False Flax (*Camelina sativa*)		1				.27	1
Fowl Meadow Grass (*Poa serotina*)	1	1				.54	2
Foxtail, Yellow (*Setaria glauca*)	135			3	8	39.42	146
Foxtail, Green (*Setaria viridis*)	128	4		4	4	37.80	140
Heart's Ease: Penn. Smartweed (*Polygonum Pennsylvanicum*)	2			2		1.08	4
Knot Grass (*Polygonum aviculare*)	1	1				.54	2
Knot-weed (*Polygonum acre*)	1			1	1	.81	3
Knot-weed, Slender (*Polygonum tenue*)	1					.27	1
Lady's Thumb (*Polygonum Persicaria*)	96			5	1	27.54	102
Lamb's Quarter (*Chenopodium album*)	45	7	1	4	2	16.13	59
Lamb's Quarter, Maple-leaved (*Chenopodium hybridum*)	2					.54	2
Lettuce (*Lactuca sativa*)	1					.27	1
Marsh-elder (*Iva axillaris*)	1					.27	1
May-weed: Dill-weed (*Anthemis Cotula*)					1	.27	1
Meadow Parsnip, Golden (*Zizia aurea*)	1				2	.81	3
Millet (*Panicum miliaceum*)	2				1	.81	3
Millet Grass (*Milium effusum*)	1					.27	1
Muskit Grass (*Bouteloua racemosa*)	1					.27	1
Mustard Black (*Brassica nigra*)	1					.27	1
Nimblewill Grass (*Muhlenbergia Mexicana*)	2				1	.81	3
Old Witch Grass (*Panicum capillare*)	31	5		1		9.86	38
Orchard Grass (*Dactylis glomerata*)	1					.27	1
Pepper-grass (*Lepidium apetalum*)	4	3		2	1	2.70	10
Persicaria, Pale (*Polygonum lapathifolium*)	3	2		2		1.89	7
Pigweed, Prostrate (*Amarantus blitoides*)					1	.27	1
Pigweed, Rough (*Amarantus retroflexus*)	64	6		4	2	20.52	76
Pigweed, Tumbling (*Amarantus albus*)	2					.54	2
Plantain, Bracted (*Plantago aristata*)	38	1	1	1	1	11.34	40
Plantain, Dooryard (*Plantago major*)	30	5		2		9.99	37
Rugel's Plantain (*Plantago Rugelii*)	111	6	3	5	1	34.06	126
Prairie Clover (*Petalostemon*)	1					.27	1
Ragweed, Small (*Ambrosia artemisiaefolia*)	3			1		1.08	4
Rape (*Brassica rapa*)	2					.54	2

	Red Clover	Aliske Clover	White Clover	Timothy	Alfalfa	Percentage of 364 Select'd Samples Examined	No. of times weed occurred in 364 samples
Ribgrass: Buckhorn English Plantain (*Plantago lanceolata*)	101	1		1	15	4.56	18
Sedge (*Carex sp.*)				1		.27	1
Shepherd's Purse (*Capsella Bursa pastoris*)		1				.27	1
Smartweed: Water Pepper (*Polygonum hydropiperioides*)	1					.27	1
Sorrel, Sheep or Field (*Rumex acetosella*)	86	29	4		1	32.4	120
Spurge (*Euphorbia Preslii*)	4			1		1.35	5
Spurge, Flowering (*Euphorbia corollata*)		1			1	.54	2
Sunflower (*Helianthus rigidus*)	1				1	.54	2
Sweet Clover (*Melilotus alba*)	1					.27	1
Thistle, Bull (*Cnicus lanceolatus*)	15	1			3	4.73	19
Thistle, Field (*Cnicus discolor*)	2				1	.81	3
Thistle, Wavy-leaved (*Cnicus undulatus*)	1					.27	1
Timothy (*Phleum pratense*)	162	46	1		2	56.97	211
Trefoil, Yellow (*Medicago lupulina*)	1					.27	1
Vervain, Blue (*Verbena hastata*)	4					1.08	4
Vervain, Hoary (*Verbena stricta*)	4			1		1.35	5
Vervain, White (*Verbena urticaefolia*)	3					.81	3
Water Hemp (*Acnida tuberculata*)	1	2				.81	3
Wild Carrot (*Dancus Carota*)	7	1		1	3	3.24	12
Wild Comfrey (*Cynoglossum Virginicum*)	1					.27	1
Wild Oats (*Arvena fatua*)	1					.27	1
Wild Turnip (*Brassica campestris*)	1					.27	1
Wormseed, Mustard (*Erysimum cheiranthoides*)		1				.27	1
Sand and Dirt	138	23	1	20	7	32.13	189
Number of samples examined, 364	255	50	5	30	24		

In this list of weed seeds attention may be briefly called to a few of the most important. The first of these is the Canada thistle occurring in thirty-two samples, quack grass in one sample, dodder in twelve samples. The farmer should refuse to purchase any seed containing the above seeds, no matter how low the price may be. In most cases they are difficult to remove from the seed and are hard to eradicate from a field. When once introduced, the Canada thistle by means of its long underground root stocks is enabled to defy extermination. When quack grass is introduced cultivation seems only to aggravate the difficulty. As for dodder it can be eliminated only by sowing seed entirely free from this weed. By reference to the maps showing distribution it will be seen that dodder and Canada thistle have already a very wide range in the state. Many of the other weeds, particularly the dodders and plantains, are also very difficult to remove from clover fields. The other weeds mentioned are for the most part already common on the average Iowa farm. Their presence in small quantity in our agricultural seeds is well nigh inevitable, yet it is believed that our clovers may be made to conform very strictly to the government standard.

The losses due directly and indirectly to the introduction of weeds with seed are among the most serious with which the farmer has to contend. They may be divided into a number of

categories. Perhaps one of the least of these, and yet one which costs the farmer many dollars, is what is paid directly for the weed seed. The following table gives the amount paid for impurities for each one hundred pounds of clover seed bought. Of

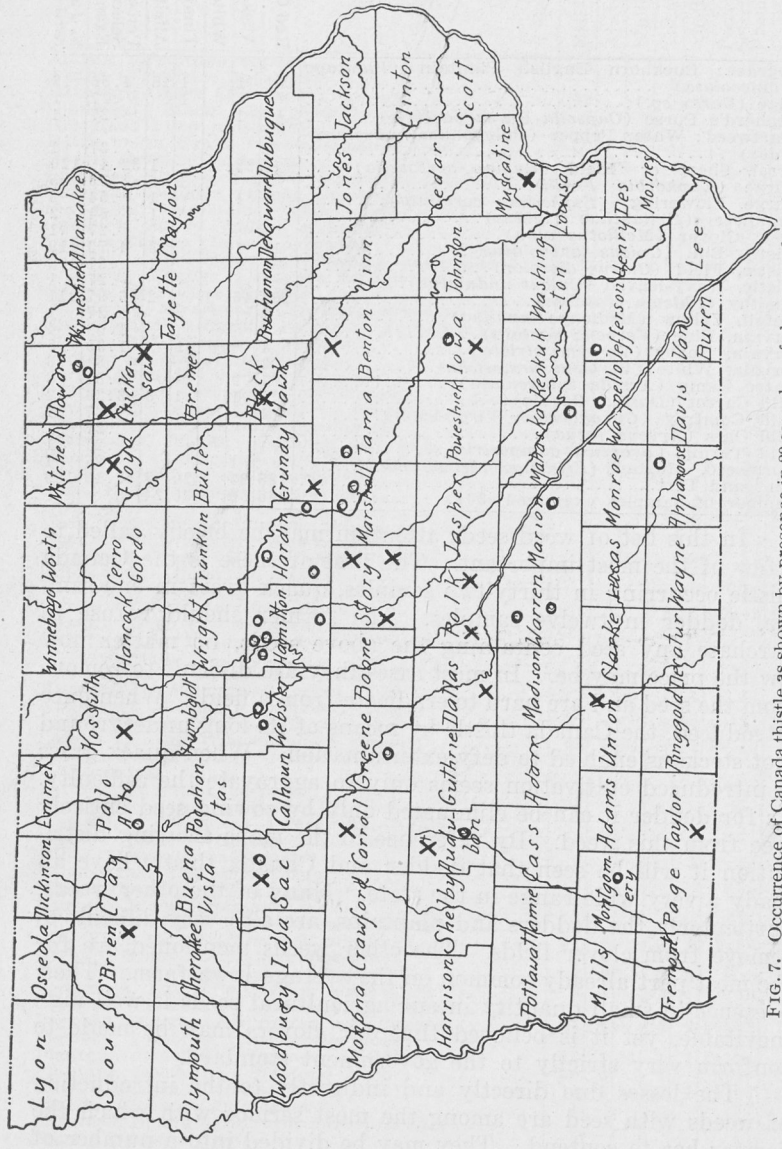


FIG. 7. Occurrence of Canada thistle as shown by presence in 29 samples of clover seed marked O. Reported occurrence marked X.

course in many instances the seed was known by the farmer to be of a poor quality when purchased, and was bought at a considerable discount. Nevertheless, it is believed that the table is conservative.

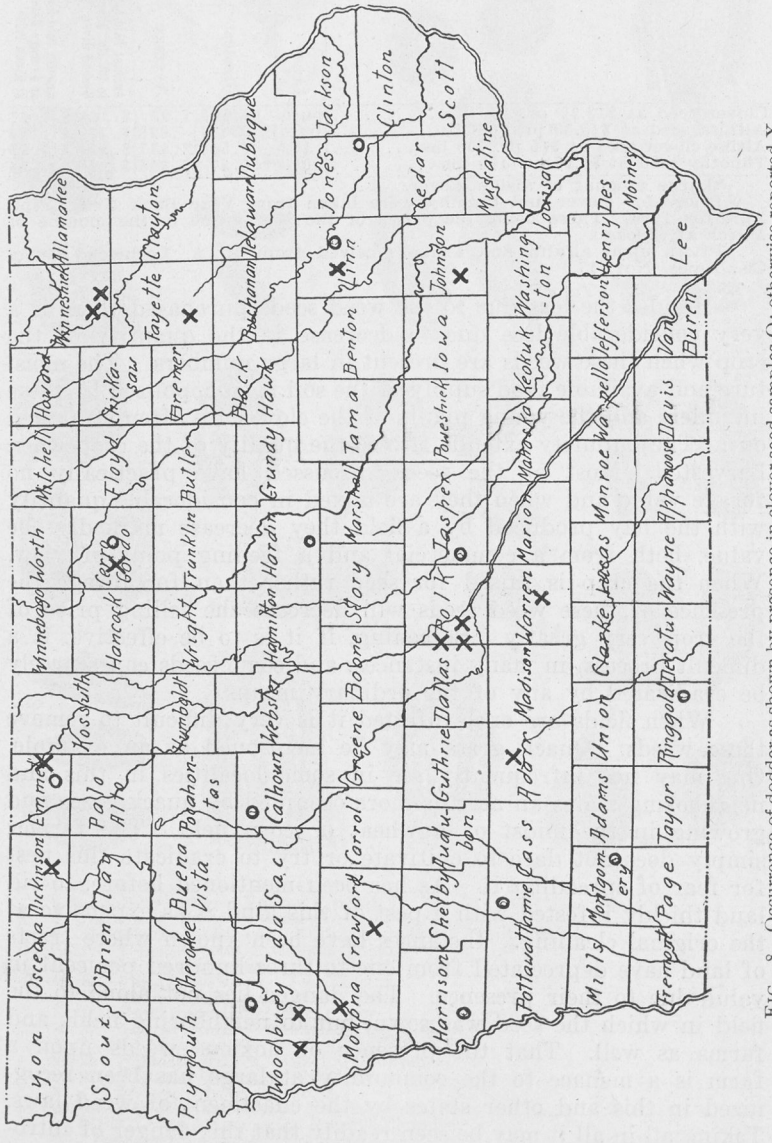


FIG. 8. Occurrence of dodder as shown by presence in clover seed samples O; otherwise reported X.

	Percentage of Impurities			Amount Paid for Impurities in 100 lbs. Average Quality Seed at Given Price	Amount Paid for Pure Seed at Average Rate of Impurity at Given Price
	Least	Greatest	Average		
Clover seed at $13.75 pr. 100 lbs.....	pure	18.606	1.93	$.264	$14.02
Alfalfa seed at $15.50 pr. 100 lbs.....	pure	2.417	.838	$.129	$15.64
Alsike clover seed at $15 pr. 100 lbs.....	.152	7.568	3.437	$.514	$15.52
Timothy seed at $3.10 pr. 100 lbs.....	.073	*16.97	7.356	$.228	$ 3.34

*Large amount of alsike clover.

Prices for clover and timothy were taken from Year Book U. S. Dept. Agr. for 1905. These being the prices of the best grade in the months of March at Chicago.

Prices upon alfalfa and alsike received from B. A. Lockwood Grain Co., Ames, Nov. 17.

Besides the loss due to the weed seeds purchased there is a very considerable loss due to decrease in the quantity of the crop when these weeds are present in large numbers. The moisture and available food supply of the soil is monopolized by these intruders and the young plants of the clover are often strangled out. The impurity extends also to the quality of the crop when harvested. Most of the seeds discussed have practically no forage value and when they are mixed in considerable quantity with the hay produced by a field they decrease markedly the value, both from a commercial and a feeding point of view. When the crop is raised for seed rather than for forage the presence of these weed seeds will decrease the selling price of the crop very greatly. Screening, if it is to be effective, is a difficult process, in many instances, and some seeds can scarcely be eradicated by any of the ordinary means.

When fields are once infested it is very difficult to remove these weeds. Quack grass may be mentioned as an example. One may not infrequently see in some localities in this and neighboring states an acre or more occupied by quack grass and growing in the midst of a wheat or corn field. The farmer simply does not dare to cultivate or try to eradicate this pest for fear of spreading it. As has been mentioned before, to rid land thickly infested with a pest of this kind is as expensive as the original cleaning. Instances have been known where tracts of land have depreciated from one to three hundred per cent in value due to their presence. The danger lies not alone to the field in which the seed was sown, but to neighboring fields and farms as well. That the presence of noxious weeds upon a farm is a menace to the community at large has been recognized in this and other states by the enactment of weed laws. Taking all in all it may be seen readily that this danger of intro-

1, 2. *Daucus Carota.* Wild Carrot.
3, 4. *Setaria glauca.* Yellow Foxtail.
5. *Agropyron repens.* Couch-grass.
6. *Amarantus retroflexus.* Rough Pigweed. Tumbleweed.
7, 8, 9. *Cnicus arvensis.* Canada Thistle.
10, 11, 12. *Cuscuta arvensis.* Dodder.
13, 14. *Cnicus altissimus.* Tall Thistle.
15, 16. *Cnicus lanceolatus.* Bull Thistle.
17, 18. *Rumex acetosella.* Sheep-sorrel.
19, 20. *Setaria viridis.* Green Foxtail.
21, 22, 23. *Phleum pratense.* Timothy.
24, 25. *Plantago aristata.* Bracted Plaintain.
26, 27. *Plantago lanceolata.* Rib-grass.
28. *Cichorium Intybus.* Chicory.
29, 30. *Lepidium apetalum.* Peppergrass.
31, 32, 33. *Plantago Rugelii.* Rugel's Plantain.
34. *Panicum sanguinale.* Crab-grass.
35. *Panicum capillare.* Old Witch Grass.
36, 37. *Rumex crispus.* Curled Dock.

ducing pests is very real, the remedy, however, lies simply in careful seed inspection.

VITALITY.

The table which has been given of the vitality of the various clovers and timothy seeds tested emphasizes more strongly than words could the necessity of making careful germination tests of the seeds of these plants. In some of the samples tested three-fourths of the seed was absolutely worthless; the farmer who sows seed such as this was, would lose not only the original cost of the seeds but probably the use of the ground for a season or at least a part of a season. Many different forms of simple apparatus have been described in various bulletins by the aid of which the farmer may test his own seed. As far as it is practicable testing of this kind will be done free of charge for the farmers of the state by the Botanical Section of the Iowa Experiment Station.

The following table gives a comparison of the vitality of seeds tested in the spring and the next fall. It will be noticed that in every instance there is decided deterioration in the quality of the seeds. This is illustrated also by the diagram which follows the tables.

COMPARATIVE VIABILITY OF PLUMP SEEDS IN THE SPRING AND FALL.

	March, 1906. Per cent of Average Germination.	November, 1906. Per cent of Average Germination.
Alfalfa	56.91	20
Alsike Clover	66.34	35.6
Red Clover	79.8	48.2

COMPARATIVE VIABILITY OF PLUMP AND SHRUNKEN SEED.

	Plump.	Shrunken.
March, 1906.		
Alfalfa	56.91	24.16
Alsike Clover	66.34	28.92
Red Clover	79.8	30.9
November, 1906—		
Alfalfa	20	10
Alsike	35.6	10.8
Red Clover	48.6	25.2

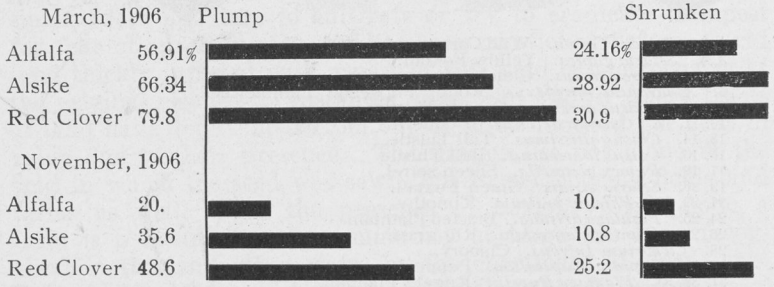


FIG. 10. THE VITALITY OF SEED, SPRING AND FALL GERMINATION.

HOW THESE CONDITIONS MAY BE REMEDIED.

Enough has been said to emphasize the importance of careful seed inspection, both for impurities and as to vitality. It is believed that this result can be reached in no way more quickly and satisfactorily than by placing the control of seed inspection into the hands of the state. Many states have passed rigorous laws of this nature, and some of the more progressive European countries have long had very stringent regulations. It is believed that no hardship would result to the dealer, if he were required to guarantee all seeds sold both as to vitality and as to purity.

The passage of a law of this nature by the Canadian parliament has resulted in a very considerable increase in the average quality of the seed sold. The object of this bill has been summarized as follows:[1]

"First, to place the seed trade on a better and more legitimate basis. During the last quarter century the Canadian seed trade has been gradually passing from the hands of the competent seedsmen into the hands of numerous local merchants whose main business is of an entirely different character. Competition has been too largely confined to prices without due attention being given to quality. Competition, under the present conditions of the seed trade, is not conductive to the production and use of the highest quality of seeds.

"Second, to suppress, as far as practicable, the dissemination of noxious weeds. The trade in agricultural seeds, especially those of grasses and clovers, is an exceedingly fruitful medium for the introduction and spread of seeds of noxious weeds from locality to locality and from province to province. This evil of the weed trade cannot be attributed so much to reliable seed houses as to the operations of merchants who are incompetent or careless in the conducting of their business."

Maine, likewise, has a law requiring a plain labeling of all packages of agricultural seeds, so as to show their purity.

The law of Kentucky forbids the mixing, adulterating or mis-branding of orchard grass, Kentucky blue-grass, red clover, mammoth clover and alfalfa.

Florida requires that seeds shall be labeled with the locality where grown. Connecticut has a law with reference to Canada thistle seed. Many other states are at the present time considering or have considered the adoption of some laws regulating and governing these sales.

It is believed that the passage of an adequate law by the legislature of Iowa would result in a benefit to the farmers of the state which, though it could not be estimated in dollars and cents, nevertheless would be none the less real. There is no reason why seeds should not be sold under as rigid a guarantee and subject to the same inspection as is being accorded to foods, fertilizers and feeding-stuffs. This inspection has proved successful elsewhere, and it should prove successful in Iowa as well.

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1 Robertson, Bull. Seed Div., Dept. Agr. Dominion of Canada, new series 15.

By no means all of the seed merchants are opposed to such legislation. We quote from a letter from a Mr. Henry Field from southwestern Iowa, who says:

"I hope you will succeed in getting some law passed regulating this weed business. What we ought to have is a national law such as they have in Canada and Germany; but if it cannot be had, we should at least have a state law. I will be glad to help it along any way I can."

SUMMARY.

During the past season the Botanical Laboratory has investigated the seeds of clover and other forage plants offered for sale in the state of Iowa. Investigations were made for impurities, adulteration and germination from 255 samples, and on 14 samples of white clover, 50 samples of alsike clover, 24 samples of alfalfa and 24 samples of timothy.

Red Clover. One hundred and thirty samples of weighed red clover were examined for impurities and adulteration, the average per cent of impurities was 1.93, the highest impurities was 33.2, only two samples consisted of pure seed. The following impurities were found in 255 samples of red clover seed in percentages as follows: Timothy, 64.8; Canada thistle, 9.2; foxtail, 54.0; dodder, 4.0; bull thistle, 6.0; sheep sorrel, 34.4; dock, 44.0, and others. Of the unweighed samples 63.8 per cent contained foxtail, 57.1 per cent timothy, 51 per cent curled dock, 47.8 per cent green foxtail, 38.6 per cent rib plantain, buck horn, or rib grass, 28.5 per cent sheep sorrel, and 11.9 per cent Canada thistle. Of the two hundred and fifty-five samples examined timothy was found in 162, sand and dirt 138, yellow foxtail 135, green foxtail 128, curled dock 110, sheep sorrel 86, bracted plantain 38, evening cockle 22, Canada thistle 24 and dodder 10. It will be seen from the above partial list that many bad weed seeds are found in clover seed. We found, further, that clover seed in some instances showed a very low vitality. Only four of the samples showed a vitality of 99 per cent and over. There was a considerable number below 80 per cent, and twenty-one samples above. In a few cases the shrivelled seeds showed a higher germination than the plump seeds. It was evident in some cases that old seed was mixed with the 1905 seed. Between March and November clover seed loses much of its vitality.

White Clover. The impurities found in weighed samples of white clover were sheep sorrel, 44.4 per cent; plantain, 33.3 per cent; bracted plantain, 11.1; lamb's quarters, 11.1; of these the sheep sorrel, dock and plantain are bad weeds. In

the unweighed samples sheep sorrel occurred in 80 per cent of the samples.

ALSIKE CLOVER. Alsike clover is not generally adulterated, but impurities were found as follows: Sheep sorrel, 86.1 per cent; plantain, 33.3 per cent; Canada thistle, 25 per cent; buck horn or rib plantain, 11.1 per cent.

ALFALFA. The chief adulterants found in alfalfa are black medic, burr clover and sweet clover. The impurities found are alfalfa dodder, 4.1; knap weed, . . ; rib-grass or buck horn, 62.5; cockle, 12.5; Canada thistle, 8.3; sheep sorrel, 4.1; plantain, 4.1; bracted plantain, 4.1; yellow fox-tail, 33.1; curled dock, 8.3.

The vitality of the alfalfa seed was very low, the average of plump seeds was 56.91 per cent and in shrunken seeds 24.16 per cent.

TIMOTHY. The chief impurities in timothy are buck horn, Rugel's plantain, curled dock and in some samples pepper grass. The vitality tests of plump seed show germination lower than the standard. The percentage for plump seeds was 64, for shrunken seeds 27.7.